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No. 80-1692

In the Supreme Court of the United States

OCTOBER TERM 1980

DECCA LIMITED,
PETITIONER

v.

UNITED STATES,
RESPONDENT

ON WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

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I

Questions Presented

(1) Whether the rule of law in eminent domain cases that the value of "just compensation" shall be no less than the value which the condemnee could have realized if he has sold his property to a reasonable and willing private buyer, applies to the evaluation of patent rights taken under Title 28 U.S.C. §1498?

(2) Whether in evaluating patent rights taken under Title 28 U.S.C. §1498 the Court of Claims can properly deny recovery for (a) manufacture (apart from use), (b) contributory infringement, (c) joint infringement, (d) induced infringement, and otherwise refuse to consider other important aspects of the value of the patents in the civilian context?

(3) By refusing to include in the award major aspects of the value of the patents, is the Court of Claims properly administering the underlying public policy and hence legislative intent of 28 U.S.C. §1498?

Designation of Parties

The Respondent in this case is the Government of the United States of America.

The Petitioner is Decca Limited, a British company.

Petitioner's statement regarding its ownership and related companies pursuant to Supreme Court Rule 28 is as follows:

Prior to April 1, 1980, Decca Ltd. was a part of The Decca Group of Companies in England. On that date, Racal Electronics Ltd. purchased a controlling interest in that group. Racal Electronics Ltd. owns a significant interest in the following list of companies. All of these companies are privately held comanies, and at the present time, none is publically traded in the stock market with the exception of Racal Electronics Ltd.

Company	*Percent*	*Country*
British Communications Corporation Ltd.	100%	England
Fairey Electronics Ltd.	100%	England
Racal Acoustics Ltd.	100%	England
Racal Automation Ltd.	100%	England
Racal-BCC Services Ltd.	100%	Ebgland
Racal-BPL Ltd.	100%	England
Racal Carlton Ltd.	100%	England
Racal-Dana Instruments Ltd.	100%	England
Racal-Datacom Ltd.	100%	England
Racal-Decca Systems and Simulators Ltd.	100%	England
Racal (East Africa) Ltd.	100%	England
Racal Electronics (Iran) Ltd.	100%	England
Racal Engineering Ltd.	100%	England
Racal Finance Ltd.	100%	England
Racal Health and Care Ltd.	100%	England
Racal Management Services Ltd.	100%	England
Racal Messenger Ltd.	100%	England
Racal Microelectronic Systems Ltd.	100%	England
Racal-Mobilcare Ltd.	100%	England
Racal-Properties Ltd.	100%	England
Racal-Redac Ltd.	100%	England
Racal-Redac Marketing Ltd.	100%	England
Racal-Research Ltd.	100%	England
Racal-Seaton Ltd.	100%	England
Racal-SSA Ltd.	100%	England
Racal-Tacticom Ltd.	100%	England
Racal-Tacticom Systems Ltd.	100%	England
Racal-Transcom Ltd.	100%	England
Racal-Zonal Cassettes Ltd.	100%	England
Racal-Zonal Ltd.	100%	England
Racal Insurance Services Ltd.	50%	England
Racal Antennas Ltd.	100%	England
Racal Hyperon Ltd.	85%	England

Company	*Percent*	*Country*
Hyperon Consulting Engineers Ltd.	85%	England
Racal Communications Ltd.	100%	England
Racal Communications Equipment Ltd.	100%	England
Racal Communications Manufacturing Ltd.	100%	England
Racal Communications Systems Ltd.	100%	England
Racal Group Services Ltd.	100%	England
Racal Milgo Ltd.	100%	England
Racal Safety Ltd.	100%	England
Racal-SES Ltd.	100%	England
Racal Recorders Ltd.	100%	England
Racal-ESL Ltd.	100%	England
Racal Information Systems Ltd.	100%	England
Racal MESL Ltd.	89%	Scotland
Racal MESL Security Ltd.	100%	Scotland
Racal Data Communications Group Ltd.	100%	England
Racal Thanet Ltd.	100%	England
Decca Ltd.	100%	England
Racal-Decca Ltd.	100%	England
Racal-Decca Navigator Ltd.	100%	England
Racal-Decca Survey Ltd.	100%	England
Racal-Decca Defense Systems (Radar) Ltd.	100%	England
Racal-Decca Marine Radar Ltd.	100%	England
Racal-Decca Concessions Ltd.	100%	England
Decca Navigator Overseas Ltd.	100%	England
Decca Survey Overseas Ltd.	100%	England
Decca Services Ltd.	100%	England
Decca Navigator Systems Germany Ltd.	100%	England
Reid and Sigrist Ltd.	100%	England
Weyrad (Electronics) Ltd.	100__	England
Decca Radio and Television Ltd.	100%	England
Planning Associates Ltd.	100%	England
Ablex Tools Ltd.	100%	England
Coastal Surveys Ltd.	100%	England

Company	*Percent*	*Country*
Decca Communications Ltd.	100%	England
Fibre Form Ltd.	100__	England
Meloto Company Ltd.	100%	England
Offshore Environmental Systems Ltd.	100%	England
Decca Software Sciences Ltd.	80%	England
Racal Electronics Inc.	100%	USA
Racal Holdings Inc.	100%	USA
Racal Airstream, Inc.	97.5%	USA
Racal Communications Inc.	95%	USA
Racal-Dana Instruments Inc.	100%	USA
Racal Exports Inc.	100%	USA
Racal-Milgo Inc.	100%	USA
Racal-Milgo Far East Inc.	100%	USA
Racal Recorders Inc.	100%	USA
Racal-Dedac Inc.	100%	USA
Racal-Vadic Inc.	90%	USA
Racal Vikonics Inc.	65%	USA
International Communications Corp.	100%	USA
ICC Export Corp.	100%	USA
Milgo Leasing Corp.	100%	USA
Interconnect Corp.	100%	USA
Racal-Milgo Electronics Corp.	100%	USA
Racal-Zonal Magnetics Inc.	99%	USA
R. E. Grimm Co.	51%	USA
Telesystems Network Inc.	100%	USA
Decca Electronics Australia Ltd.	100%	Australia
Decca Constructors Pty Ltd.	100%	Australia
Decca Radar A/S	100%	Denmark
Decca Survey Denmark A.P.S.	100%	Denmark
Racal-Decca Pilot A/S	100%	Denmark
Decca Insko A/S	100%	Denmark
Internationale Navigatie Apparaten Nv.	50.1%	Holland
Decca Surveys Services Holland B.V.	100%	Holland

Company	*Percent*	*Country*
Formerly Decca Radar OG Navigator A/S (Now Racal-Decca Norge A/S	100%	Norway
Decca Survey Norway A/S	100%	Norway
Decca Services (Nigeria) Ltd.	40%	Nigeria
Deram Holdings Ltd.	100%	Canada
Deram Ltd.	100%	Canada
Decca Navigator A/S	100%	Denmark
Decca Navigator Italiana S.P.A.	100%	Italy
Sea Surveys Ltd.	100%	Eire
Decca Survey (Malaysia) SDN Bhd.	70%	Malaysia
Decca Survey France S.A.	55%	France
Decca Surveys (South East Asia) (PTE) Ltd.	100%	Singapore
The Decca Navigator Co. (S. Africa) (PTY) Ltd.	75%	South Africa
Decca Contractors S. Africa (PTY) Ltd.	100%	South Africa
Decca Navigator Radar A.B.	100%	Sweden
Decca Survey Sweden AB	100%	Sweden
Decca Radar S.A.	100%	Switzerland
West Africa Surveys Ltd.	100%	Nigeria
Decca Electronics Inc.	100%	USA
Decca Navigator Systems Inc.	100%	USA
Racal-Decca Survey Inc.	100%	USA
Navigation Systems Inc.	100%	USA
ITT Decca Marine	50-125%	USA
Racal-Decca Survey (Latin-America) Inc.	100%	USA
Racal-Decca Survey of Panama S.A.	100%	Panama
Decca Survey Do Brasil Equipamentos E Pesquisas Ltda.	100%	Brazil
Racal-Decca Marine (Ireland)	100%	Eire
Decca Survey KK	50%	Australia
High Frequency Communications (Aust) Pty. Ltd.	100%	Australia
Tape Recorders Pty. Ltd.	95%	Australia
Racal Electronics Belgium SA	100%	Belgium

Company	*Percent*	*Country*
Racal Elektronik GmbH	100%	Germany
Racal-Milgo GmbH	100%	Germany
Racal-Dana Instruments S.A.	100%	France
Racal-Redac SA	100%	France
Racal Electronics Europe B.V.	100%	Holland
New Venture Electronics Ltd.	100%	Jersey
Racal Electronics (Malaysia) SDN. BHD	70%	Malaysia
Racal-SMD Electronics Proprietory) Ltd.	100%	South Africa
Racal Finance Pty Ltd.	100%	South Africa
Racal Electronics (Singapore) Private Ltd.	100%	Singapore
Racal Electronics S.A.	100%	Switzerland
Racal (Canada) Ltd.	100%	Canada
Racal-Zonal Magnetics Ltd.	99%	Canada
Electrofirm S.A.	100%	France
ICC Argentina	100%	Argentina
ICC Brazil	100%	Brazil
Decca Navigator (Japan) Ltd.	100%	England
Dolphin Petroleum Ltd.	51%	England
Communications Distribution and Export Co. Ltd.	50%	England
Communications Associates of Nigeria Ltd.	30.6 %	Nigeria
Decca (West Africa) Ltd.	40%	Nigeria
Record Manufactors of Nigeria Ltd.	35%	Nigeria
S.I. and Decca Flight Navigator Ltd.	50%	England
Radarbras Equipamentos Electronicos Ltdo.	40%	Brazil
Oil Search Marine Management Ltd.	20%	England
Irish Hydrodata Ltd.	50%	Eire
Industrial De Comunicacoes Coencisa S.A.	49%	Brazil
Equipos De Radiocomunicacion Compania de Economia Mixta	49%	Ecuador
Racal Electronics SA	100%	Switzerland
Racal Exports, Inc.	100%	USA

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TJO - Trial Judge Opinion on Accounting
FF - Court of Claims Finding of Fact on Accounting

In the
Supreme Court of the United States

OCTOBER TERM 1980

No.

DECCA LIMITED,
PETITIONER

v.

UNITED STATES,
RESPONDENT

ON WRIT OF CERTIORARI
TO THE UNITED STATES COURT OF CLAIMS

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

The petitioner, Decca Limited, respectfully prays that a writ of certiorari issue to review the judgment of the Court of Claims entered in this proceeding on November 19, 1980.

Opinions Below

The final judgment of the Court of Claims holding Decca Limited's U.S. Patent No. 2, 844,816 valid and infringed is reported as *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F2d 1070 (C.Cl. 1976) and appears in the Appendix hereto at pages A-52 to A-101. The opinion of the Trial Judge on the accounting is reported as *Decca Ltd.* v. *United States*, Ct. Cl. 206 USPQ 1041 (C.Cl 1979) and appears in pages A-102 to A-193 of the Appendix hereto. The opinion of the Court of Claims on the accounting (not yet reported) appears in pages A-1 to A-43 of the Appendix hereto. The Findings of Fact of the Trial Judge appear in the Appendix at

pages A-130 to A-192; the Order of the Court of Claims amending the findings appears in the Appendix at pages A-44 to A-51; the Order of the Court of Claims denying rehearing is printed in the Appendix at page A-194; and for purposes of providing a convenient way to illustrate the effect on the Trial Court's findings of the order of the Court of claims amending same, we append hereto the findings of the Trial Court with the amendments of the Court of Claims entered therein (deletions bracketed, additions underlined), at pages A-195 to A-258 of the Appendix.

Jurisdiction

The judgment of the Court of Claims in the accounting phase was entered on November 19, 1980. A timely motion for rehearing and suggestion for rehearing en banc according to Rule 151(b) of the Court of Claims was made on December 4, 1980. That motion was denied on January 9, 1981, and this petition for certiorari was filed within 90 days of that date. This Court's jurisdiction is invoked under 28 U.S.C. §1255(1).

Statutory Provisions Involved

Constitution of the United States — AMENDMENT V

AMENDMENT V — CAPITAL CRIMES; DOUBLE JEOPARDY; SELF-INCRIMINATION; DUE PROCESS; JUST COMPENSATION FOR PROPERTY

No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the Militia, when in actual service in time of War or public danger; nor shall any person be subject for the same offense to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation.

United States Code, Title 28 Judiciary and Judicial Procedure — SECTION 1498 (Section a)

§1498. Patent and copyright cases

(a) Whenever an invention described in and covered by a patent of the Untied States is used or manufactured by or for the United States without license of the owner thereof or lawful right to use or manufacture the same, the owner's remedy shall be by action against the United States in the Court of Claims for the recovery of his reasonable and entire compensation for such use and manufacture.

For the purposes of this section, the use or manufacture of an invention described in and covered by a patent of the United States by a contractor, a subcontractor, or any person, firm, or corporation for the Government and with the authorization or consent of the Government, shall be construed as use or manufacture for the United States.

The court shall not award compensation under this section if the claim is based on the use or manufacture by or for the United States of any article owned, leased, used by, or in the possession of the United States prior to July 1, 1918.

A Government employee shall have the right to bring suit against the Government under this section except where he was in a position to order, influence, or induce use of the invention by the government. This section shall not confer a right of action on any patentee or any assignee of such patentee with respect to any invention discovered or invented by a person while in the employment or service of the United States, where the invention was related to the official functions of the employee, in cases in which such functions included research and development, or in the making of which Government time, materials or facilities were used.

35 USC §271 (a),(b),(c)

§271. Infringement of patent

(a) Except as otherwise provided in this title, whoever without authority makes, uses or sells any patented inven-

tion, within the United States during the term of the patent therefor, infringes the patent.

(b) Whoever actively induces infringement of a patent shall be liable as an infringer.

(c) Whoever sells a component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use, shall be liable as a contributory infringer.

Statement of the Case

Petitioner, Decca Limited, purusant to Title 28 U.S.C. Section 1498, filed suit in the Court of Claims in 1970 to recover compensation for the manufacture and use by and for the United States of the Omega world-wide navigation system, claiming that that system infringed petitioner's United States Patent No. 2,844,816 (herein the '816 patent).

The Court of Claims in the liability phase of the case held the '816 patent valid and infringed and that, because defendant had designed, built, financed, monitored and operated it from a control position in the United States "the whole Omega system must be deemed, at least for purposes of litigating the patent here involved, to be a unity, and the location of that unity must be deemed to be in United States territory" (A-57). Under the rules of the Court of Claims the judgment in the liability phase of the case was a final judgment (Rule 131(c)(2)) and the United States did not seek a review thereof by petition for certiorari in this Court. An accounting proceeding was then held.

The Trial Court, at the conclusion of the accounting, made a large number of findings of fact relevant to each of the three basic approaches for evaluating the rights taken, i.e. (a) cost savings, (b) lost profits, and (c) reasonable royalty. More specifically, the Trial

Court found, among other things, that "the infringing Omega system is unique (A-182 (TJF 151)), that it was a "significant advance over the best available alternative (A-122 lines 24-25 (TJO)), that its uniqueness "was made practical by its use of the '816 patent" (A-142 to A-143 (TJF 59)), that it is the only system "capable of effective use by submerged submarines" (A-130 to A-131 (TJF 25); A-182 (TJF 151)), that there was an "urgent military and non-military requirement for the Omega system" (A-183 (TJF 153)), that the Government experimented for ten years, after Decca's first disclosure in 1954 (A-130 to A-131 (TJF 25)) to develop a non-infringing system but were unable to do so (A-131 (TJF 27)) and elected in 1964 to build the infringing Omega system (A-133 (TJF 34 and 36)), and that it would cost the Government $640 million less to build and operate Omega for a ten year period than the next best alternative (A-142 to A-143 (TJF 59); A-181 (TJF 149); A-182 (TJF 151), and A-193).

The Trial Court then found that, if the reasonable royalty approach were to be followed, since there never had been a prior sale of Omega equipment from which a royalty rate could have been *established*, (A-181 (TJF 149)), and in view of the tremendous advantages of Omega over all other systems, including Decca's own short-range MK X system[1], a royalty rate of 10% would be appropriate, the appropriate royalty base would include the cost of all of the Government's manufacture in process and procurements for the entire Omega system, and would generate an award of $17.89 million (A-142 (TJF 56 and 57); A-142 to A-143 (TJF 59 and 60); A-186 (TJF 160)). The Trial Court, however, concluded further that, since the Government's taking had completely ousted Decca from the Omega system-related market and had left Decca powerless to re-enter the market when the Government cut back the funds for Omega in 1972, the Government's procurements were not a complete measure of the value of the rights taken

[1] Which the Trial Court found to be not "anywhere near comparable" to Omega (A-181 (TJF 149)).

(A-143 (TJF 62); A-185 (TJF 158)), and that based on cost saving alone, "Decca, in arm's length negotiations, could have justifiably bargained for a higher payment than the mere $17.89 million arrived at by the licensing approach" (A-143 (TJF 64)). The Trial Court then went on to find an award of $24.8 million based on a conservative percentage of cost savings of $640 million (A-144 (TJF 65)).

The case then came before the Court of Claims, which rejected both the cost savings and lost profits approaches and based the award on the reasonable royalty approach (A-20 to A-21). In so doing, however the Court of Claims eliminated from the award all accounting for the Government's very substantial manufacture in process,[2] and contributory, joint and induced infringements of the '816 patent as well as infringing equipment stored in a disassembled state, and based the award solely on the Government's use of certain fully operational components stating "That is all we are permitted to award, even though plaintiff might have obtained a larger amount if the infringer had not been the Government" (A-20). In addition, without denying their factual accuracy, the Court of Claims also cancelled *all* of the Trial Court's findings relating to the lack of prior sales of Omega equipment from which a royalty rate could be established and the tremendous cost and performance advantages of the infringing Omega system over all other available alternatives (A-141 (TJF 54 and 55); A-142 to A-143 (TJF 59); A-143 (TJF 64); A-181 to A-183 (TJF 149-152); A-185 (TJF 158); and A-186 (TJF 160)), stating "we are not

[2] The statement of the Court of Claims (at A-13) that "use" was the only basis for recovery sought by petitioner is in error. Petitioner sought recovery based on manufacture apart from use in its Brief After the Accounting Trial at pages 23, 47-53, and in its requested findings I-18, and II 8(a) to 8(d). In addition, the Trial Court based its award, if the reasonable royalty approach were to be used, in part on manufacture apart from use (see in particular A-142 (TJF 57) in which the first five items are manufacture in process, see also A-142 to A-143 (TJF 59 and 60); A-186 (TJF 160)).

compelled to evaluate that possibility" (A-20) and reduced the award to $2 million (exclusive of delay damages).

Reasons for Granting Certiorari

I. Brief Summary of Reasons for Granting the Writ

Briefly stated (without details or case citations) the reasons for granting the writ are that, by the decision below, the Court of Claims has made a major departure from the basic tenet in eminent domain cases that the value of the condemnee's rights against the Government (i.e. the value of "just compensation") shall be no less than the value those rights could generate in a sale to a reasonable private buyer. Thus, the Court below refused to include in the award anything for the very substantial manufacture of the Omega system by the Government apart from its use even though the right to license manufacture apart from use is a valuable right in the civilian context. The Court below also refused to award anything for contributory infringement, joint infringement, or induced infringement, although all three were found in the case at bar and all three also are valuable in the civilian context. Further, the Court below refused to award anything for possession by the Government of infringing equipment which had been manufactured and procured but which was stored in a disassembled state. This was formerly held to be a proper basis for an award. Beyond this, the Court below held, also contra to prior case law, that in assessing the value of a "reasonable royalty" the Court need not take into account major elements of the value of the patented item such as its cost savings and performance advantages compared to the next best alternative, and further, that it can devalue the award based on events which occurred *after* the date of the taking, also contra to prior case law. These holdings of the Court below amount to a blunt decree that the Government can now take a private party's patent rights, and not award that party just compensation, as just compensation has been defined by

this Court, in a number of significant ways. The decision below is not only a serious departure from the decided cases, but if allowed to stand, would render §1498 unconstitutional. A writ of certiorari to the Court of Claims is required to set the matter straight and preserve the constitutionality of the Act.

A more detailed statement of the reasons for granting the writ follows:

II. WHETHER THE RULE OF LAW IN EMINENT DOMAIN CASES THAT THE VALUE OF "JUST COMPENSATION" SHALL BE NO LESS THAN THE VALUE WHICH THE CONDEMNEE COULD HAVE REALIZED IF HE HAD SOLD HIS PROPERTY TO A REASONABLE AND WILLING PRIVATE BUYER AT THE TIME OF THE GOVERNMENT'S TAKING, APPLIES TO THE EVALUATION OF PATENT RIGHTS TAKEN UNDER TITLE 28 U.S.C. §1498?

The infringement of a patent by or for the Government is a taking of property by right of eminent domain for which *just compensation* must be paid by the Government to satisfy the Fifth Amendment of the Constitution; *William Cramp & Sons Ship & Engine Building Co.* v. *International Curtis Marine Turbine Co., et al.*, 246 US 28, 41-43 (1918); *Richmond Screw Anchor Co.* v. *United States*, 275 US 331 (1928). Just compensation is defined as the fair market value of the property taken at the time of the taking as willing buyers and willing sellers would evaluate it at that time. In *Almota Farmers Elevator & Warehouse Co.* v. *United States*, 409 US 470 (1973), the Supreme Court stated at pages 473-74:

> The Fifth Amendment provides that private property shall not be taken for public use without "just compensation." "And 'just compensation' means the full monetary equivalent of the property taken. The owner is to be put in the same position monetarily as he would have occupied if his property had not been taken." *United States* v. *Reynolds*, 397 U.S. 14, 16 (footnotes omitted). See also *United States* v. *Miller*, 317

> U.S. 369, 373. To determine such monetary equivalence, the Court early established the concept of "market value": the owner is entitled to the fair market value of his property at the time of the taking. *New York* v. *Sage*, 239 U.S. 57, 61. See also *United States* v. *Reynolds*, *supra*, at 16; *United States* v. *Miller*, *supra*, at 374. And this value is normally to be ascertained from "what a willing buyer would pay in cash to a willing seller." *Ibid.* See *United States* v. *Virginia Electric & Power Co.*, 365 U.S. 624, 633.

and at page 478:

> "The constitutional requirement of just compensation derives as much content from the basic equitable principles of fairness, *United States* v. *Commodities Trading Corp.*, 339 U.S. 121, 124 (1950), as it does from technical concepts of property law." *United States* v. *Fuller*, *post*, at 490. It is, of course, true that Almota should be in no better position than if it had sold its leasehold to a private buyer. But its position should surely be no worse.

In addition, it is clear that "all reasonable factors" bearing on the value of the rights taken are pertinent. In *Amerace Esna Corp.* v. *United States*, 199 Ct.Cl. 175, 462 F2d. 1377, 174 USPQ 517 (Ct.Cl. 1972), adopting 172 USPQ 305 (C.Cl. 1972), the Court of Claims affirmed and adopted Commissioner Colaianni's statement, reported at 172 USPQ 305, 308, that:

> In the end, what is being attempted is to establish what the parties would have agreed upon, if both were reasonably trying to reach an agreement. Factors which are pertinent to such a determination include the nature of the invention, its utility and advantages, and the cost of savings expected by the use of the invention.[6] In sum, this approach attempts to consider all reasonable factors that each side would urge to advance its own best interests in an arm's-length negotiation.

(Footnote omitted).

In the case at bar, the Court of Claims found (A-32) that the patent rights taken must be evaluated as of June 1965 because that is the date when defendant published both its intention to build the infringing world-wide Omega navigation system, and its election to serve in the role of prime contractor in the design, erection, testing and operation of the Omega system. The date of 1965 was also selected because it was then that the license which defendant took commenced having the effect of totally and permanently eliminating petitioner from the Omega system-related market, as the Court below so found (A-32 to A-33).

Facts bearing on the value of the license taken by the Government at that time to make the Omega system are as follows:

(1) Over a ten year period Omega would cost $640 million less than Loran-C, the next best alternative (A-142 to A-143 (TJF 59); A-181 (TJF 149); A-182 (TJF 151); A-193)

(2) Decca's own MK X system was less effective than Loran-C for long range navigation and would be more expensive than Loran-C for world-wide coverage (A-181 (TJF 149))

(3) Omega was the only system by which continuously submerged submarines could navigate, as a practical matter (A-181 (TJF 149))

(4) The Omega system was unique, i.e. a world first (A-182 (TJF 151))

(5) Defendant had an urgent military and non-military requirement for the Omega system (A-183 (TJF 153))

(6) The uniqueness of the Omega system was made practical by its use of the '816 patent (A-142 to A-143 (TJF 59))

(7) The effect of defendant's taking was to exclude Decca from the Omega system-related market because of the world-wide, single system nature of Omega (A-133 to A-134 (TJF 35 and 37); A-185 (TJF 158))

With these facts, at a negotiating table in 1965 or even in October 1967 when defendant first declared the Omega system

operational (Interim Operational), petitioner could have bargained for a payment taking all of those values into consideration and the Trial Court below concluded from them that Decca could have justifiably bargained for a payment greater than $17.89 million (A-143 (TJF 64)). The Trial Judge then awarded Decca $24.8 million based on a highly conservative share (i.e. 4%)of the $640 million cost saving figure over Loran-C.[3]

The Court of Claims, however, cancelled all of the findings of fact of the Trial Court bearing on the comparative value of the infringing Omega system over both Loran-C and the Decca MK X system (a-134 (TJF 38); A-141 to A-144 (TJF 54-65); A-181 to A-183 (TJF 149-152); A-185 to A-186 (TJF 158-160)), and reduced the award to $2 million (i.e. .3% of the previously estimated cost saving A-193).

The Court below justified this drastic reduction on the basis of two factors both of which were actually unrelated to the value of the license which defendant took for Omega.

The first of these was the granting by Decca of a license to Bendix for the Decca MK X system. The Decca MK X system was a relatively small, medium range (400 n. mi.) system (it uses the '816 patent but at a different frequency and in a different context, i.e. in-shore navigation). Based upon the testimony of the expert witnesses and an examination of the documents, the Trial Court found it not "anywhere near comparable" to Omega (A-181 (TJF 149)).

Although the Court below acknowledged that Decca's Bendix license granted no rights to Omega (A-23), and that the "reasonable royalty" approach was being followed[4], the Court

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[3] The lowest percentage previously awarded when basing an award on the cost saving method was 20%, *Shearer* v. *United States*, 101 Ct. Cl. 196, 60 USPQ 414 (C.Cl., 1944), cert. denied, 323 US 676 (1944).

[4] The statement by the Court at A-31 that there was an "established rate" did not apply to Omega. It was derived from TJF 127 (A-174 to A-175) which applied to the MK X system, not Omega. The Trial Court uniformly found a rate of 10% of the cost of the entire Omega system ap-

below took the Bendix license as virtually the *sole indicium* of the value of the '816 patent applicable to Omega and used both its royalty rate, i.e. 7½% and its limited definition of "transmitter" as applying to Omega. The Court below then, however, ignored the payment provisions of that license, which called for a royalty on items sold regardless of use thereof by the customer, and limited the award to use by the Government saying "That is all we are permitted to award, even though plaintiff might have obtained a larger award if the infringer had not been the Government" (A-20).

The second fact which effectively led the Court below to reduce the award was defendant's decision in 1972 to cut back the funds for Omega.

In 1965 and 1967 and for some years thereafter defendant intended to build the entire eight station Omega system and procure some $60 million worth of three frequency receivers by 1972. At the earlier 1965 or 1967 dates, in view of the complete and permanent ouster of Decca from the Omega system-related aspect of its patent rights, Decca could have justifiably bargained for a license payment based on competitive bidding for construction of the entire system because that is what Decca was giving up, and the Trial Court so found (A-142 to A-143 (TJF 59); A-186 TJF 160)). In 1972, however, when defendant cut back the funds for Omega, Decca was powerless to re-enter the field because defendant continued to control the Omega project (A-185 (TJF 158)). The Court below, however, by restricting the award to only those components which had finally been placed in operating condition, has gauged the quantum of the taking, not in relation to what was taken in 1965 or 1967, but as of the latter 1972-1975 decision to cut back the funds.

By cancelling the Trial Court's findings relating to the cost savings and performance advantages of the '816 patent and otherwise

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plicable to Omega (A-142 to A-143 (TJF 59); A-186 (TJF 160)) and based this finding on the cost and performance advantages of Omega over the MK X system as enumerated above.

basing the award on factors which both ignore those pertinent values and diminish the award based on later events totally unrelated to the value of the patent rights at the time of the taking, the Court below has departed from the decided cases which hold that just compensation must be no less than the value to the condemnee in a sale to a private buyer at the time of the taking, *Almota Farmers* (supra), and that "all reasonable factors" bearing on the evaluation must be taken into consideration, *Amerace* (supra).

In the case at bar the difference between considering these factors, and ignoring them, as the Court below has done, is enormous. Taking them into consideration as the Trial Court did, yields an award of $24.8 million, whereas ignoring them yields $2 million, or $22.8 million shy of "just compensation" determined in the usual way.

If section 1498 were to permit the Court of Claims to cut awards below the level of just compensation as the Court of Claims now interprets the Section, the Section would be unconstitutional, *Cramp* (supra); *Richmond Screw* (supra); *Almota Farmers* (supra).

It is incumbent on the Courts, however, to avoid, whenever possible, an interpretation of a statute which renders the statute unconstitutional, *Richmond Screw* (supra at p. 346). Accordingly, certiorari to the Court of Claims is required to review the decision below with a view toward reversing and remanding it with instructions that in determining the quantum of "reasonable and entire" compensation under §1498, the Court must award no less than "just compensation" (i.e. the value in the civilian context), that "all reasonable factors" bearing on the evaluation must be considered, that the fair market value at the time of the taking is controlling, that the Trial Court followed the correct procedure by considereing all such factors, and that the Trial Court's findings be adopted.

III. WHETHER IN EVALUATING PATENT RIGHTS TAKEN UNDER TITLE 28 U.S.C. §1498 THE COURT OF CLAIMS CAN PROPERLY DENY RECOVERY FOR (A) MANUFACTURE (APART FROM USE), (B) CONTRIBUTORY INFRINGEMENT, (C) JOINT INFRINGEMENT, (D) INDUCED INFRINGEMENT, AND OTHERWISE REFUSE TO CONSIDER OTHER IMPORTANT ASPECTS OF THE VALUE OF THE PATENTS IN THE CIVILIAN CONTEXT?

Since awards under §1498 are governed by the rules applicable to eminent domain takings, it follows that the condemnee must not be placed in a worse position financially against the Government than he would be vis-a-vis a private buyer, i.e. in the civilian context, *Almota Farmers* (supra at p. 478).

The Court of Claims, however, has now held that a number of elements of value of patents in the civilian context are not applicable to evaluations under §1498 as follows:

(a) *No award for contributory, joint, or induced infringement*

For example, in the decision below, the Court of Claims has now held that no recovery can be had against the government for contributory, joint, or induced infringement even when there is an on-going direct infringement in both the use and manufacturing senses. In the civilian context, however, the rights to recover money or grant licenses for contributory, joint, or induced infringement apart from direct infringement are valuable rights. By the decision below, those rights are now worthless against the government. The contributory or joint infringer cannot be sued, *Marconi Wireless Telegraph Co.* v. *Simon*, 246 US 46 (1918); and no recompense from the government is awarded for it even though both the contributory and joint infringer as well as the infringement inducing Government benefit from it. This holding by the court of Claims is in direct conflict with the decision in *Almota Farmers* (supra), because it places the patent owner in a decidedly

worse position financially than if he had sold his rights to a private buyer, because the private buyer would have had to pay for contributory, joint, or induced infringement.

(b) *No recovery for manufacture (apart from use)*

In the case at bar, there is no dispute that the Government itself was the manufacturer of the infringing Omega system and was continuously exercising a license (taken by eminent domain) to manufacture the Omega system from 1965 until the expiration of the '816 patent. Further, no one denies that that license to manufacture was highly valuable. By holding, however, that the award herein must be limited solely to use by the Government of operative components of the Omega system, the Court of Claims has, in effect, held that no recovery can be had against the Government for manufacture by or for the Government separately from use even in a case where the proof of the separate value of the rights to manufacture is clear, as in the case at bar. In the civilian context, however, manufacture apart from use or sale is an infringement and the rights of the patent owner as to it are separately valuable. Thus, in the case of *Neff Instrument Corp.* v. *Cohu Electronics, Inc.* 269 F2d 668, 122 USPQ 554 (CA 9, 1959) the Court stated:

> [3] By the grant of a valid patent, the owner obtains an exclusive right, not only to prevent use by another of his invention, but likewise the making or the selling of the article, in the disjunctive. See 235 U.S.C. §154. Just as the manu-
> [4] facture of one machine by an infringer is sufficient to make the manufacturer liable, regardless of use or sale, Caterpillar Tractor Co. v. International Harvester Co., supra, so one sale is sufficient. Hutter v. De Q. Bottle Stopper Co., 2 Cir., 1904, 128 F. 283; B.B. Chemical Co. v. Cataract Chemical Co., W.D. N.Y. 1938, 25 F.Supp. 472, 476, 39 USPQ 339, 342. And see, U.S.C. §271(a).

Accordingly, in the civilian context, patent owners can grant licenses solely for manufacture and the right to do so is valuable, but now, despite the specific provisions in §1498 that recompense shall be awarded for manufacture *or* use, in the disjunctive, the Court of Claims has held that that right is worthless apart from use whenever the government is concerned.

Petitioner knows of no decided case in the Court of Claims prior to the case at bar holding that manufacture apart from use is not compensable. In fact, the words "manufacture or use" from Section 1498 are always quoted in the disjunctive, and the Court of Claims frequently indicates at least the possibility of basing awards on manufacture alone (for example, even in the case at bar it is recognized, (A-9). Also, in *Tektronix* v. *United States*, 216 Ct. Cl. 144, 575 F2d 832, 198 USPQ 378 (C. Cl. 1978), cert. denied 439 US 1048 (1978), the Court of Claims, while acknowledging that manufacture is compensable under 28 USC §1498, held in that particular case (at USPQ p. 381) that there was "no evidence to establish the date of manufacture of the infringing items".[5] In the case at bar, however, there is a large volume of evidence establishing the dates of defendant's manufacture and the value thereof (A-137 to A-139 (TJF 44-45, 47-51); A-142 (TJF 56); A-209 to A-239 (FF 66-71, 75-77, and 79-126); A-183 (TJF 154)). This evidence shows that defendant, acting as its own prime contractor in the construction of the system, controlled the manufacture in

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[5] In *Coakwell* v. *United States*, 178 Ct. Cl. 654, 658-9, 372 F2d 508, 511, 153 USPQ 307, 308-9 (1967), the Court below stated that "liability ordinarily attaches when the device is delivered to the purchaser and hence is available for use". Of course, in the ordinary case manufacture may take only a few hours or days. Thus, in the ordinary case, the difference in the award between manufacture and delivery may be so small as to be not worth pursuing. This does not mean, however, that, in a non-ordinary case where the value of a license to manufacture (apart from use) may be highly valuable, as in the case at bar, no liability arises under Section 1498.

process of all of the completed stations and three large incompleted stations (LaReunion, Argentina and Liberia)[6], and large quantities of three frequency receivers purchased and received but still not completely assembled. The values involved in that manufacture are fully documented in the evidence of record. The Trial Court included all of those items in its recommendation for the award on the reasonable royalty basis (A-142 to A-143 (TJF 59); A-186 (TJF 160)). The Court of Claims, however, without challenging their factual accuracy, totally eliminated them from consideration. Nothing was awarded for equipment which, even though manufactured, was not put in operation.

The Court did not, in so many words, state that manufacture in process is not compensible under Section 1498, but the undisputed evidence of vast manufacture by defendant apart from use and its value is so clear in the case at bar, that the holding of the Court below (over-ruling the Trial Court's findings which included manufacture apart from use in the award) that liability arises only for defendant's use, is such a holding.

That Section 1498 covers continued manufacture once an infringing manufacture has been established is not only supported by the plain meaning of the words of the Act, but is confirmed by its legis'ative history. In fact, the whole point of the change from the Act of 1910 to that of 1918 was to make it possible for governmental suppliers to continue to manufacture things for the Government without fear of being enjoined by patent owners for infringement of patents, *Richmond Screw Anchor Company* v. *United States*, 275 US 331 (1928). If after the passage of the Act of 1910 an injunction against manufacture in process for the Government had not been available to patent owners, and the only

[6] In fact, the Court below had accentuated the issue by changing the Trial Court's finding TJF 94 (A-157) to emphasize that those three stations were completely built and operational but for one small thing, i.e. the tapping of their helix coils (A-222 (FF 94)). Thus, the Government had virtually totally already benefited from the license under the '816 patent to manufacture the Omega system. The Court below, however, by accentuating that no recovery can be had therefor, seems to be testing whether manufacture which is complete but for the tightening of a final "nut and bolt", still escapes liability under §1498.

remedy available had been against the party who ultimately uncrated the products, assembled and used them, i.e. the Government (as the Court below now holds), suits against the Government under the Act of 1910 which provided recompense for such use by the Government, would have been their only recourse. This Court, however, in *William Cramp & Sons Ship & Engine Building Co.* v. *International Curtis Marine Turbine Co. et al*, 246 U.S. 28, 41-43 (1918) held that patent owners have the right to exclude others from the manufacture of their patented inventions, that it is a property right which cannot be taken by the Government without just compensation under the Fifth Amendment, and that since the 1910 Act referred only to "use by or for" the Government and did not provide recompense for manufacture for the United States, patent owners still retained the right to sue governmental suppliers to enjoin their continuing manufacture (i.e. manufacture *in process*). The holding in *Cramp* (supra), therefore, not only made it necessary for Congress to add the word "manufacture" to the Act in order to obtain immunity from suit for governmental suppliers, but also made clear that the word "manufacture" as used in the Act was intended to mean *continuing* manufacture, i.e. manufacture in process (see *Opinion of the Comptroller General*, 151 USPQ 221 1966)). Thus, by eliminating from the award liability for defendant's very substantial manufacture process, the Court below contravenes the plain meaning of Section 1498 as construed in the light of its legislative history.[7] Also, if Section 1498 were to be construed, as the Court below now construes it, i.e. that the Government is not liable for manufacture in process, then Section 1498 would be unconstitutional as allowing the taking of property without just compensation.

[7] This construction of Section 1498 is also in conformity with the underlying objectives of offering incentive to inventors to make inventions not only in small, quickly manufactured items, but also in large, difficult-to-build items (i.e. rolling mills, blast furnaces, power plants, space vehicle launchers, world-wide navigation systems, to name only a few) for which, due to the possible expiration of the patent prior to the completion, the license to manufacture may be much more valuable than a license to use or sell, as it was in the case at bar.

(c) *No awards for infringing articles purchased by the Government but retained in an incompletely assembled state*

In addition, in the civilian context, patent owners normally obtain a royalty based on the sale price of any goods coming under the license which are manufactured, sold and delivered regardless of whether the customer ever assembles them or, in the case of a transmitter, taps its helix coil. Prior to the case at bar, the same applied to awards in the Court of Claims, *Olsson* v. *United States*, 87 Ct. Cls. 642, 25 F. Supp. 495, 37 USPQ 767 (C.Cl. 1938), cert. denied 307 US 621 (1939). In fact, as recently as *Leesona* v. *United States*, 220 Ct.Cl. , 599 F2d 958 (C.Cl. 1979), cert. denied 444 US 991 (1979), the Court of Claims was still adhering to that doctrine. In *Leesona* (supra) a substantial portion of the award granted by the Court of Claims was based on battery boxes and electrodes (in the Government's initial order of them) which were retained by the Government in storage in an unassembled state. Now, however, by the decision below, the Government is no longer liable for the manufacture and procurement of non-staple components of a patented combination and the retention of them in an unassembled state.[8]

In the Court below, defendant argued that, to the extent that the Court below's present ruling is in conflict with *Olsson* (supra), the Supreme Court has over-ruled *Olsson* (supra) in *Deepsouth Packing Co.* v. *Laitram*, 406 US 518, (1972). *Deepsouth* (supra), however, holds only that, where a combination of staple articles of commerce is intended to be assembled for the first time in an infringing manner *in a foreign jurisdiction*, there is no infringement

[8] One wonders what this new rule of law will do to the statute of limitations and how will the patent owner learn about the infringement? Since the manufacture by itself is now not actionable, according to the decision below, when will the cause of action for the infringement arise? Usually, the only way a civilian can learn of an infringement is by the publication of procurement contracts let. How, by the new rule of law, will the patent owner ever find out when the Government decides to use the patented devices?

in the United States for the mere manufacture of the staple articles. However, where non-staple articles are concerned, which are suitable only for use in the patented combination, as in the case at bar, and the intention is to assemble and use them in the United States, also as in the case at bar, a different picture is presented. In the latter case, as the Supreme Court stated in *Deepsouth* (supra, at 173 USPQ p. 772), the production and even the sales activity is an infringement. In addition, the Court of Claims already held in the liability opinion "that *Deepsouth* really is not in point" in the case at bar (A-70).

(d) *Nothing can be awarded in the Court of Claims to account for the full value of the license taken, in circumstances when the Government fails fully to use the license, while still precluding the patent owner from using the patent*

Again, in the civilian context, when a license is to be granted which will have the effect of totally and permanently eliminating the patent owner from the market involved in the licensed subject matter, the patent owner usually requires some form of protection such as a guaranteed minimum, or a right of re-entry should the licensee fail or otherwise decide not aggressively to pursue the commercialization of the invention. By the decision below, however, when dealing with the Government, patentees must take their changes, and suffer the consequences should the Government arbitrarily decide not to use, to its full logical extent, the license it takes, while still precluding the patent owner from re-entering the field and trying to make up the difference.

(e) *No account need be taken in the Court of Claims of comparative values between the patented item and the next best alternatives*

Finally, in the civilian context when negotiating for a reasonable royalty, many factors are taken into account such as the cost saving of the licensed items compared to the available

alternatives, the profitability of the patented item and the improved performance of the patented device over the available alternatives. The Trial Court, in arriving at its recommended royalty rate and royalty base, if the reasonable royalty approach were to be followed, took all of these factors into account (cost saving $640 million), (A-141 to A-144 (TJF 55, 59, 64 and 65); A-181 to A-182 (TJF 149, and 151)); profitability of $32 million, (A-141 (TJF 54)); A-182 and A-183 (TJF 152); and superior performance capability, i.e. "unique" system, reaches submarines, etc. (A-181 to A-182 (TJF 149, 151)), and concluding that petitioner could have justifiably bargained for a payment of *greater* than that based on the reasonable royalty approach, i.e. $17.89 million (A-143 (TJF 64)), awarded $24.8 million based on cost savings alone. The Court of Claims, however, even though professing to be following the "reasonable royalty" approach (A-21), simply cancelled all of those findings stating "we are not compelled to evaluate that possibility" (A-20), thereby eliminated those elements of value from its consideration of both the royalty rate and the royalty base. Such factors, however, would be highly relevant in the determination of a reasonable royalty in a willing buyer-willing seller negotiation in the civilian context, and would have hitherto also been relevant in the Court of Claims, *Amerace* (supra).

Thus, by the decision below, the Court of Claims has ruled in clear terms that henceforth patent owners will be in a substantially reduced position financially when dealing with the Government compared to dealing in the civilian context. Since just compensation under the Fifth Amendement requires that the condemnee be placed in no worse a position financially than if he had sold his patent rights "to a private buyer", *Almota Farmers* (supra at p. 478), it follows that Section 1498 would be unconstitutional as permitting the taking of property without just compensation, if the interpretation of the Court below of Section 1498 were correct.

This is not to say that additional amounts should be added to the licensing value of the patents taken, to compensate the patent owner for his loss of business opportunity beyond the scope of the

license, or his loss of exclusivity, to both of which the Court below referred in its opinion (A-26 to A-27). Nor do we say that attorney's fees and exemplary damages should be awarded. Since the Government is deemed to have a license available to it, whenever it wishes to take it, the patent owner never enjoys immunity from infringement by the Government in the first place, and as for attorney's fees and exemplary damages, since a license is available to defendant (even though one may properly question whether the Government should not even bother to evaluate private patent rights), the manner of the taking is undoubtedly irrelevant. In the case at bar, however, the Court of Claims has gone a great deal farther, and has eliminated from awards all consideration of manufacture in process, contributory, joint and induced infringement. It also has over-ruled *Olsson* (supra). Beyond this, it has held that when following the "reasonable royalty" approach, there is no need to take into consideration values such as cost savings and performance differences in direct conflict with the prior ruling of the Court of Claims in *Amerace* (supra). Thus, the decision below which eliminates those elements of infringement and values from consideration does not merely affect the award to petitioner herein, but sets a precedent contra to *Almot Farmers* (supra) whereby the rights of all patent owners will henceforth be substantially less against the Government than in the civilian context. In fact, the Court below frankly admitted that this is the effect of its decision by stating (A-20) "That is all we are permitted to award, even though plaintiff might have obtained a larger amount if the infringer had not been the Government". We think the Court below is diametrically in error. We think that the Court below is required by the Constitution to award to the condemnee no less than the value which it could have obtained if the rights had been sold to a private buyer. Since the decision below thus is in conflict with *Almota Farmers* (supra) and *Richmond Screw* (supra), and amounts to a failure to grant just compensation, certiorari is required to prevent these departures from the decided cases, to correct the error, and to preserve the constitutionality of the Act.

IV. By refusing to include in the award major aspects of the value of patents, is the Court of Claims properly administering the underlying public policy and hence legislative intent of 28 USC §1498?

Totally apart from satisfying the Fifth Amendment, awarding ample compensation for the Government's taking of patent rights is justified by the public policy of providing incentive for inventors to invent and disclose to the public inventions in the areas of technology in which the Government is interested. Those areas are apt to be quite different from the civilian areas of technological interest and can involve such things as missile or space guidance of launching systems, navigations sytems, global rescue systems, weapons control systems, etc. Thus it is important to the Government (and hence to the public) that the incentive to make inventions in such areas and to disclose them to the Government remain high.

When the Court of Claims, however, reduces the value of civilian patent rights against the Government as outlined in the foregoing sections, although it may be saving the tax-payer money in the short run, it also is reducing the incentive to inventors to invent in the areas of important governmental interests and may lose the tax-payer money or other benefits in the long run. Thus, in the future, if the decision below is allowed to stand, there will be substantially less incentive for a person to invent any combination having particular usefulness to the Government especially combinations the manufacturing of which is likely to take a long time, because the Government would be in a position, according to the Court below, to purchase and stockpile in an unassembled state any number of the patented items it chooses, or engage in the long-term manufacture of a large system, and escape all payments either for items purchased, or for the manufacture, merely by delaying the final hook-up of one small part of the combination. The inventor would be better advised to direct his efforts to items

relevant to the civilian market, where his patent rights will afford him better protection. It would seem that by using the words "reasonable and entire" in §1498, Congress was specifically calling for a liberal interpretation for awards in keeping with the underlying policy of maintaining the incentive for inventors in areas of governmental interest. The Court of Claims, now, however, has decided in favor of a major reduction in that incentive. Petitioner respectfully suggests that the time has come after 50 years of silence on the subject of awards in the Court of Claims,[9] for the Supreme Court to stem the negative trend of the decision below and to provide the Court of Claims with guidelines for interpreting Section 1498 which include the granting of awards for manufacture in process, joint infringement, contributory and induced infringement, which make clear that all of the licensing values of patent rights in the civilian context apply equally against the Government and that the value to be employed is the value at the time of the taking and not some other value influenced by earlier or later events. Certiorari should be granted to review the decision below with a view toward reversing and remanding it with instructions to amend the award in keeping with the policy of preserving for the public, the benefit of the incentives to inventors of Government-oriented inventions as originally intended by Congress under Section 1498.

Respectfully submitted,

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[9] The most recent decided case was *Waite* v. *United States*, 282 US 508 (1931) (opinion by Justice Holmes) which dealt with delay compensation. The most recent case which dealt with the main issues of scope and constitutionality was *Richmond Screw* (supra) in 1928 with which the present decision of the Court below is in conflict.

United States Court of Claims

No. 299-70
(Decided November 19, 1980)

DECCA LIMITED v. THE UNITED STATES

Robert B. Russell, attorney of record, for plaintiff. *Henry C. Nields* and *Russell & Nields*, of counsel.

John J. Fargo, with whom was *Assistant Attorney General Alice Daniel*, for defendant. *B. Frederick Buchan, Jr.*, and *Vito J. DiPietro*, of counsel.

Before NICHOLS, KASHIWA, and SMITH, *Judges*.

OPINION

SMITH, *Judge*, delivered the opinion of the court:

In an earlier opinion in this case,[1] the court held that claims 1, 4, and 11 of U.S. Patent No. 2,844,816 (the '816), issued July 22, 1958 and owned by plaintiff Decca Limited (Decca), were valid and infringed by the United States (the Government). The case was referred to Trial Judge Browne for a determination of the amount of "reasonable and entire compensation" to which Decca is entitled under 28 U.S.C. § 1498 (1976). The case is now before the court on the Government's exceptions to Trial Judge Browne's findings of fact, opinion and recommended conclusion of law. Decca has not excepted to any finding of fact or to the recommended conclusion of law; in almost all respects, Decca concurs in the trial judge's opinion.

We do not adopt the trial judge's opinion or his recommended conclusion of law. Although we have not appended hereto his findings of fact, we adopt them except as stated hereinafter and by separate order. In the separate order, we indicate what findings we adopt without modification, what findings we adopt as corrected by us, and what findings we reject without replacement.

[1] *Decca Ltd. v. United States*, 210 Ct. Cl. 546, 544 F.2d 1070 (1976).

We make our own determination of the quantum of recovery. The facts giving rise to our determination are stated. Any fact statements not having counterparts in the findings are to be taken as additional findings of the court.

I.

A. The '816 claims a radio navigation system in which three very low frequencies emitted by each of two or more transmitters at fixed locations are received by a receiver capable of lane-resolving.[2] The receiver accomplishes lane-resolving through its phase-difference indicator. The phase-difference indicator is operated by means of a coarse control and a fine control. The coarse control frequency-differences the signals received from each transmitter and then phase-compares the difference-frequencies, derived from the signals from one transmitter, with the difference-frequencies derived from the signals from another transmitter. The fine control phase-compares the lowest-frequency signals received from one transmitter with the lowest-frequency signals received from another transmitter. The frequency-differencing and phase-comparing enable the receiver to lane-resolve and to determine (a) a single hyperbolic line of position (LOP) if signals from only two transmitters have been received, and (b) a position fix from two intersecting hyperbolic LOP's where signals from three transmitters have been received.

Claim 1 of the '816 is an "independent" claim. Claims 4 and 11 are each dependent on claim 1 and are, therefore, of narrower scope than claim 1.[3] Specifically, claim 4 is limited to a system in which three frequencies radiated from each of two or more transmitters are radiated in sequence. Claim 11 relates to a system in which the signals are radiated from three transmitters and the timing of the transmission of the signals is coordinated.

B. (1) The infringing system in the case at bar is the Omega

[2] For a more detailed description see our earlier opinion in *Decca Ltd.*, *supra* note 1.

[3] See Appendix A for a reproduction of claims 1, 4, and 11.

system. Omega is a worldwide, very-low-frequency (VLF) radio navigation system designed, developed, constructed, and operated by the Government. The fully established system contemplated that the signal-generating component of Omega would consist of eight permanent transmitting stations, each station transmitting a three-frequency format.

In June 1964, the Government published a report containing a complete technical layout for the establishment of Omega. The report defined Omega as a worldwide system consisting of eight transmitting stations. In June 1965, the Government authorized and announced its authorization of a project to establish and operate Omega. The project was a "CNM-Designated Project." This meant that the Government, utilizing supervision by the Chief of Naval Materiel, was assuming the role of prime contractor for the project.[4]

By October 24, 1967, four three-frequency transmitting stations had been constructed and had achieved interim operational capability (IOC). These IOC stations were located in Norway; Trinidad; Forrestport, New York; and Hawaii. On October 24, 1967, the Government officially declared the IOC stations to be "interim operational." By this declaration the Government guaranteed that the stations would continuously transmit the Omega three-frequency format for at least 1 year.[5]

In September 1968, the Government authorized the establishment of eight permanent Omega stations. The stations were to provide a system of worldwide radio navigation and were to be located in Norway, North Dakota, Hawaii, Japan, Liberia, La Reunion Island, Argentina, and Australia. As of July 22, 1975, the expiration date of the '816, the Government had established the

[4] Overall responsibility for the project was vested in the Omega Project Office of the United States Navy.

[5] The IOC stations in Norway and Hawaii were eventually converted into permanent Omega stations. The IOC station in Trinidad remained operational beyond July 22, 1975, the expiration date of the '816. The IOC station in Forrestport ceased functioning as an Omega station in 1973.

permanent Omega system to the following extent: The permanent stations in Norway North Dakota, Hawaii, and Japan had been constructed and were operational;[6] substantial, though not complete, construction of the stations in Liberia, La Reunion Island, and Argentina had occurred. The Government was in possession of all necessary station electronics for the latter three stations. The three stations were not operational, however, because their helix coils had not been "tapped." Construction of the eighth station in Australia had not commenced, but contracts had been let for all essential material for construction of the station. The Government had either ordered or was in possession of all necessary station electronics for the station.

(2) A necessary component of the Omega system is a receiver capable of receiving and processing all three frequencies transmitted by Omega stations. A receiver can resolve lane ambiguity only if it has such capability and receives and processes all three Omega frequencies.[7]

The history of the Government's procurement of three-frequency receivers usable with Omega is as follows. The first use of the three-frequency Omega format occurred by June 1966. By that date, six companies had made and had tested three-frequency breadboards in anticipation of the Government's soliciting bids for a contract for three-frequency receivers. By September 30, 1967, the Government was operating a bank of three receivers, each

[6] The station in North Dakota was declared operational on October 1, 1972. The permanent station in Norway was declared operational on December 20, 1973. The permanent station in Hawaii was declared operational in January 1975. The station in Japan was declared operational on April 30, 1975.

[7] The Omega format is comprised of 10.2 kHz, 13.6 kHz, and 11-1/3 kHz signals.

After lane ambiguity has been resolved, a receiver can determine its position merely by receiving and processing the 10.2 kHz frequency of the Omega format. Hence, although a single-frequency receiver is not capable of resolving lane ambiguity, it can determine its position after it has been "initialized" through use of the full three-frequency Omega format. Initialization of a single-frequency receiver occurs when its beginning position is determined (a) by reference to a position indicated by a nearby three-frequency receiver or (b) in the case of a tuneable single-frequency receiver, by tuning it to each of the three frequencies.

having only single frequency capability. Although the bank was receiving the full Omega format, the bank itself was not capable of lane-resolving and, hence, of determining position. To determine position through use of the bank, it was necessary for a human being to process the data provided by the bank. Neither a phase-difference indicator operated by a fine control and a coarse control nor a mechanical equivalent thereof was a component of the bank.

The Government first used a single receiver capable of lane-resolving in the manner taught by the '816 in June 1969. At that time, it installed and tested in an aircraft an AN/ARN-99(XN-1) receiver. The AN/ARN-99(XN-1) was the first automatic three-frequency receiver manufactured for the Government. During the term of the '816, the Government installed and used two AN/ARN-99(XN-1)'s and two AN/ARN-99(XN-2)'s.

The Government converted the AN/ARN-99(XN-1) into a receiver usable with submarines.[8] The converted receiver was an automatic three-frequency receiver labeled the BRN-7.[9] During the term of the '816, the Government assembled and installed in submarines eighteen BRN-7's. In addition to the installed BRN-7's, seventy-seven BRN-7 receiver sets[10] were delivered to the Government during the term of the '816.

Two other three-frequency receiver models were used by the Government during the term of the '816: the AN/ARN-99(V)1 and the AN/ARN-99(V)4. Although sixty-four AN/ARN-99(V)1 receiver sets were delivered to the Government during the term of the '816, the Government assembled and installed only 14 of these prior to the expiration of the '816.[11] Eighteen AN/ARN-99(V)4

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[8] Northrop Corporation developed, pursuant to a contract with the Government, the software which was used to accomplish the conversion.

[9] The Government engaged Northrop Corporation to perform "first article" testing with respect to four BRN-7's.

[10] A receiver set consists of the unassembled components of a receiver.

[11] It should be noted that, an addition to the 64 delivered sets, thirty-one AN/ARN-99(V)1 sets had been manufactured, but not accepted by the Government, prior to the expiration of the '816.

receiver sets were delivered to the Government during the term of the '816. Of these, two were assembled and installed prior to the expiration of the '816.

The AN/ARN-99(V)4 and the BRN-7 each process Omega signals by means of a computer which is built into the receiver. The computer provides a hyperbolic LOP readout. The AN/ARN-99(V)1 lacks a built-in computer. It must be connected to a general-purpose computer which is part of the craft or vessel on which the AN/ARN-99(V)1 is installed. The general-purpose computer processes Omega signals received by the AN/ARN-99(V)1. One of the fourteen AN/ARN-99(V)1's installed during the term of the '816 was connected to a general-purpose computer which provided a hyperbolic LOP readout. The other thirteen AN/ARN-99(V)1's installed during the term of the '816 were connected to general-purpose computers which provided only latitude/longitude readouts.

(3) Decca did not participate in the establishment of Omega and incurred no expenses in connection with the Government's project. Decca did not design any transmitters or three-frequency receivers for use with Omega. It did not develop any of these or other Omega components. During the term of the '816, it did not manufacture any Omega components for the Government. However, throughout the term of the '816, it was free to bid on procurement contracts let by the Government for Omega components. Moreover, because of the '816, Decca was in a position to control the civilian market for three-frequency Omega receivers.

Although Decca did not participate in the establishment of Omega, it utilized claims 1 and 11 of the '816 in building Decca Navigator Mark X (Mk X) systems. The Mk X is a low-frequency (LF), short-range system of radio navigation. While Mk X equipment is smaller than Omega equipment, the technical aspects of the operation of the two systems are virtually the same. Moreover, the problems encountered in erecting an Mk X system are substantially the same problems encountered in erecting Omega. By the expiration of the '816, Decca had erected and sold more than 40 Mk X systems.

Decca's sales of Mk X systems were in direct competition with sales of Loran-C systems. Loran-C is an LF hyperbolic navigation system. It was at the time the only feasible alternative to Omega in the context of choosing a system to provide worldwide navigation coverage. Prior to establishing Omega, the Government had installed and was operating Loran-C systems which provided navigation coverage of much of the Northern Hemisphere.

(4) Commercial licenses under the '816 were granted by Decca. In an agreement dated November 9, 1961, Decca, through its wholly owned American subsidiary, Decca Navigator System, Inc. (DNSI), granted, to Bendix Corporation, the first license to include the '816. The license authorized Bendix to make, have made, use and/or sell transmitters and receivers for Decca Navigator systems, including the Mk X, and Dectra systems. Encompassing the '816 and 60 other patents, the license was exclusive. Granted along with the license, in the same agreement, were a right of access to Decca's technical information concerning the licensed patents and a right to use Decca's trademark. The agreement (hereinafter the entire agreement will be referred to as the Bendix license) provided for a royalty rate of 7.5 percent to be applied to the net selling price of receivers, transmitters, and parts.

The Bendix license contained the following definition of transmitter :

> * * * "Transmitter" shall mean all the technical equipment used in the production of satisfactory and reliable Decca or Dectra service from, but not including, the primary power supply to, and including, the dispatch of the service, but shall not include land, building, vehicles, diesels, real property improvements and the primary power supply.

The definition indicated what components of the price charged for constructing a transmitting station were to be excluded from the royalty base.

The Bendix license provided for an additional exclusion from the royalty base. This exclusion was stated as follows:

> * * * In the case of sales or rentals under contracts involving research and development effort the net selling price or rental shall be an equivalent fair market value of the apparatus actually delivered and shall exclude payment received for research and development effort not directly reflected in the fair market value of the apparatus.

On March 31, 1969, Decca, again through DNSI, licensed ITT Navigator Systems, Inc. (ITT/NSI), to make, have made, use and/or sell "Licensed Equipment" Decca Navigator systems, Dectra systems, and Omega (hereinafter the ITT/NSI license). "Licensed Equipment" was defined as transmitters, receivers, and parts "made or marketed by or for" Decca. In the case of "Licensed Equipment" for Omega, the qualification "if and when developed" was added to a description of the covered equipment.

The ITT/NSI license encompassed 29 patents, one of which was the '816. The license was to be exclusive after other, then outstanding licenses expired in October 1970. Licensed along with the 29 patents were Decca's know-how and trademarks relating to the patents.

The ITT/NSI license provided for a royalty base consisting of the net selling price of "Licensed Equipment." With respect to covered equipment for Decca Navigator systems and Dectra systems, the license specified a royalty rate of 7.5 percent. With respect to covered equipment for Omega, the license specified a royalty rate of 5 percent. The 5 percent rate was to be applied for the 5-year period following the date of the first sale of covered Omega equipment. At the expiration of the 5-year period, the rate was to decrease to 2.5 percent except for items covered by one or more licensed patents which had not expired by the end of the 5-year period. The royalty rate for each excepted item was to remain at 5 percent until the item was no longer covered by an unexpired licensed patent.

II

Under 35 U.S.C. § 154 (1976), the owner of a United States patent is entitled "for a term of seventeen years [following the issuance of the patent]* * *to exclude others from making, using, or

selling the [patented] invention throughout the United States." Section 1498 of 28 U.S.C. (1976)[12] authorizes the Government to take, through exercise of its power of eminent domain, a license in any United States patent.[13] Section 1498 provides the *sole* remedy available to a patentee for an eminent domain taking of a license in his patent. The remedy is monetary and must be pursued by means of an action in this court.

Section 1498 provides that the Government takes a license in a patent when one or more of the following incidents occur: manufacture or use by or for the Government of a patented invention. The section further provides that manufacture or use of a patented invention by a contractor, for and with the authorization of the Government, is to be "construed" as manufacture or use for the Government.

The Government takes a license to use or to manufacture a patented invention as of the instant the invention is first used or manufactured by the Government. The license taken at that instant covers only what the Government is using or has manufactured as of that instant. If, after this first taking, the Government expands the scope of its use of the invention or manufactures additional units of the invention, the Government engages thereby in incremental takings. Each incremental taking vests the patentee with a new cause of action.[14]

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[12] Section 1498 reads in relevant part:

"(a) Whenever an invention described in and covered by a patent of the United States is used or manufactured by or for the United States without license of the owner thereof or lawful right to use or manufacture the same, the owner's remedy shall be by action against the United States in the Court of Claims for the recovery of his reasonable and entire compensation for such use and manufacture.

"For the purposes of this section, the use or manufacture of an invention described in and covered by a patent of the United States by a contractor, a subcontractor, or any person, firm, or corporation for the Government and with the authorization or consent of the Government, shall be construed as use or manufacture for the United States."

[13] *Leesona Corp.* v. *United States*, 220 Ct. Cl. ___, 599 F.2d 958, *cert. denied*, 444 U.S. 991 (1979); *Crozier* v. *Krupp*, 224 U.S. 290, 305 (1912).

[14] *Irving Air Chute Co.* v. *United States*, 117 Ct. Cl. 799, 93 F. Supp. 633 (1950).

Because section 1498 authorizes the Government to take a license in any United States patent, the Government is never "guilty" of "direct infringement" of a patent insofar as "direct infringement" connotes tortious or wrongful conduct. The Government has a right to take patent licenses and cannot be enjoined from doing this. Moreover, a contractor engaging in patent-infringing manufacture or use pursuant to an authorization thereof contained in a procurement contract with the Government cannot be enjoined from its patent-infringing activity. As stated earlier, the contractor's activity is deemed under section 1498 to be for the Government. Hence, the activity is clothed with the authority of the eminent domain power.

Because section 1498 is an eminent domain statute, the Government has consented thereunder only to be sued for *its taking* of a patent license. Expressed differently, section 1498 is a waiver of sovereign immunity only with respect to a direct[15] governmental infringement of a patent. Activities of the Government which fall short of direct infringement do not give rise to governmental liability because the Government has not waived its sovereign immunity with respect to such activities.[16] Hence, the Government is not liable for its inducing infringement by others, for its conduct contributory to infringement of others, or for what, but for section 1498, would be contributory (rather than direct) infringement of its suppliers. Although these activities have a tortious ring, the Government has not agreed to assume liability for them. In short, under section 1498, the Government has agreed to be sued only for its direct infringement of a patent.

The redress provided by section 1498 for such a direct infringement is "reasonable and entire" compensation for the patent

[15] Direct infringement of a patent consists generally of making, using, or selling the patented invention. With respect to the Government, direct infringement refers to governmental use or manufacture of the patented invention. Of course, governmental use or manufacture can occur either through authorized actions of governmental employees or through actions by contractors specifically authorized by the Government to engage in the actions for the Government.

[16] *See Leesona Corp.* v. *United States*, *supra* note 13.

license taken by the Government pursuant to its direct infringement.[17] One of the two components of "reasonable and entire" compensation for the license is the value of the license, determined ordinarily as of the time the Government takes the license. However, if the taking is an integral part of a governmental project involving more than one license-taking and if the Government announced, prior to the taking, that it would engage in the project, the value of the license must be determined as of the time the Government announced the project.[18]

To appraise a patent license taken by the Government, the court utilizes one of three methods of valuation: (1) determination of a reasonable royalty for the license;[19] (2) awarding a percentage of governmental cost savings arising from governmental use of the patented invention;[20] or (3) awarding lost profits.[21] Determination of a reasonable royalty for the license is the preferred method of valuation.[22] Where (a) *prior* to the time as of which the license taken by the Government is to be valued, the patentee has licensed the infringed patent commercially and (b) the rights of such a commercial licensee are the same or substantially similar to the rights taken by the Government, the court uses, virtually without exception, the reasonable royalty method to value the license taken by the Government.

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[17] The measure of recovery quoted from section 1498 is equivalent to the just compensation which the fifth amendment mandates for every governmental taking. *Calhoun* v. *United States*, 197 Ct. Cl. 41, 453 F.2d 1385 (1972).

[18] *See United States* v. *Miller*, 317 U.S. 369 (1943).

[19] *Calhoun* v. *United States*, *supra* note 17; *Amerace Esna Corp.* v. *United States*, 199 Ct. Cl. 175, 462 F.2d 1377 (1972); *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106 (1976), *cert. denied*, 434 U.S. 1051 (1978); *Leesona Corp.* v. *United States*, *supra* note 13.

[20] The court has used this method in only three cases: *Shearer* v. *United States*, 101 Ct. Cl. 196, *cert. denied*, 323 U.S. 676 (1944); *Marconi Wireless Tel. Co.* v. *United States*, 99 Ct. Cl. 1(1942), *rev'd in part*, 320 U.S. 1 (1943); and *Olsson* v. *United States*, 87 Ct. Cl. 642, 25 F. Supp. 495 (1938), *cert. denied*, 307 U.S. 621 (1939).

[21] *Imperial Mach. & Foundry Corp.* v. *United States*, 69 Ct. Cl. 667 (1930).

[22] *Leesona Corp.* v. *United States*, *supra* note 13.

The other component of "reasonable and entire" compensation for a patent license taken by the Government is delay compensation. Delay compensation is recompense for the Government's delay in paying for the license. Ordinarily, the court deems the value of the license to be payable as of the time the Government takes the license.[23] Hence, delay compensation begins to accrue, ordinarily, as of the date of the taking; and it continues to accrue to the date of payment of the judgment. When the court uses the reasonable royalty method to value the license, the court determines delay compensation by multiplying accrued royalties by an appropriate annual percentage rate. For the period 1947-75, the court uses the rates established in *Pitcairn*.[24] With respect to years after 1975, the court uses the 7.5 percent rate set by *Pitcairn* for the 1971-75 quinquennium, unless a plaintiff affirmatively demonstrates that a higher rate should be used.[25]

III.

A. We turn now to a consideration of what the Government has taken from plaintiff, and when. The '816 claims a radio navigation *system*. Although the '816 describes the system in terms of the functions of the components of the system (the transmitters and the receivers), the components are not separately patented under the '816. Only their combination or integration into the system is patented thereunder. Thus, manufacture or use of operational transmitters, if this manufacture or use is not combined with manufacture or use of one or more operational receivers, does not directly infringe the '816. Direct infringement does not occur until a system, comprised of two or more transmitters and one or more receivers, has been constructed and is available for use.[26] In the

[23] *Tektronix, Inc.* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, *cert. denied*, 439 U.S. 1048 (1978).

[24] *Pitcairn* v. *Unites States*, *supra* note 19.

[25] *Tektronix, Inc. v. United States*, *supra* note 23. In the instant case, Decca has shown that 8 percent should be used for years after 1975.

[26] *See Deepsouth Packing Co.* v. *Laitram Corp.*, 406 U.S. 518 (1972). That case holds that, where the novelty of a patented machine arises from the particular configuration in which its components are combined, mere manufacture of the unassembled components of the machine does not amount to manufacture of the

liability phase of this case (*Decca I*), we have determined that "it is when the receiver receives the signal * * * that there is a completed use of the system."[27]

B. Trial Judge Browne determined that the Government first took a license in the '816 on October 24, 1967, the date the Government declared the Omega IOC stations to be "interim operational." The trial judge based his determination, in part, on his finding that the Government's use by this date of the bank of three single-frequency receivers constituted a direct infringement of the '816. The Government argues that the bank is not similar to the Omega receiver models found to infringe in *Decca I* and, hence, that the trial judge's finding of direct governmental infringement as of the date in question is erroneous.

In *Decca I*, Decca accused two Omega receiver models to be infringing: the AN/ARN-99 and the BRN-7. Decca limited its proofs of infringement to these models. The court determined that the models were infringing.

To decide in the accounting phase of a patent infringement case whether an article not accused to infringe in the liability phase is infringing, the court limits its inquiry to the issue of whether the article is similar in structure and in mode of operation to the items found to infringe in the liability phase.[28] More specifically, the court examines the article to determine whether it has features similar to the patent-infringing features of the items. In the instant case, the issue is whether the bank of three single-frequency receivers is similar, in relevant respects, to the AN/ARN-99 and the BRN-7. We find that the bank lacks similarity.

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machine and, hence, does not directly infringe the patent claiming the machine. In other words, the "combination patent protects only against the operable assembly of the whole and not the manufacture of its parts." *Id.* at 528. That this is so even if the parts can be assembled to form the machine in less than 1 hour is made clear by *Deepsouth Packing Co.*

[27] *Decca Ltd.* v. *United States*, *supra* note 1, 210 Ct. Cl. at 567, 544 F.2d at 1082.

[28] *Pitcairn* v. *United States*, *supra* note 19; *Marconi Wireless Tel. Co.* v. *United States*, *supra* note 20; *Flat Slab Patents Co.* v. *Turner*, 285 F. 257 (8th Cir. 1922).

The three single-frequency receivers comprising the bank were not interconnected. Hence, the bank could not effect a completed use of the system because it could not frequency-difference the three-frequency format transmitted by an Omega station. Because it could not frequency-difference the format, it could not lane-resolve. It lacked, in short, a phase-difference indicator operated by means of a fine control *and* a coarse control. The AN/ARN-99 and the BRN-7, on the other hand, each had such a phase-difference indicator. Through the operation of this phase-difference indicator, they were able to lane-resolve.[29]

The trial judge's determination that the Government had directly infringed the '816 by October 24, 1967, was based solely on his finding that the Government had used by this date the bank of three single-frequency receivers. The trial judge did not make a finding of any other basis for determining that the Government had directly infringed the '816 as of the date in question. Decca did not request the trial judge to make such a finding. Yet Decca contends now that, as of October 24, 1967, the National Aeronautics and Space Administration (NASA) was using a multifrequency receiver to receive Omega signals and that use of this receiver constituted direct infringement of the '816. The short answer to this belated contention of Decca is that it is not substantiated by evidence of record. The record does not indicate the specific struc-

[29] The ability to lane-resolve of the receiver described in the '816 is the heart of the '816 invention. The bank lacked this ability. Although, at this stage of the case, it is necessary merely to find that the bank is not similar to the AN/ARN-99 and the BRN-7, it is clear that the use of the bank did not infringe the '816.

It is true that a human being could lane-resolve by processing data provided by the bank. But such lane resolution would be the product of computations done by the human being, not the product of frequency-differencing and phase-comparing done by the bank. The structural element vesting the receiver described in the '816 with lane-resolving capability is a phase-difference indicator operated by means of a fine control and a coarse control. The processing of data by a human being is not the equivalent of this phase-difference indicator. *Brown* v. *Davis*, 116 U.S. 237 (1886).

ture of the NASA receiver or the actual starting date of use of the receiver.

In addition to determining that the Government had directly infringed the '816 by October 24, 1967, Trial Judge Browne determined that, by this date, the Government had engaged in active inducement of infringement and in contributory infringement. The trial judge cited the pre-1967 use of three-frequency breadboards by six private companies as an example of the Government's having induced infringement.[30] According to the trial judge, 35 U.S.C. §§ 271(b) and (c) (1976), which impose liability on private persons for their active inducement of infringement and their contributory infringement, are incorporated by implication in 28 U.S.C. § 1498 (1976). Hence, under the trial judge's construction of section 1498, the Government is liable not only for its direct infringement of a patent but also for its active inducement of infringement and its contributory infringement.

We disagree with the trial judge's construction. Section 1498 expressly waives the Government's sovereign immunity only with respect to governmental direct infringement of a patent. Nowhere in the section is active inducement of infringement or contributory infringement mentioned, either directly or by cross-reference to 35 U.S.C. §§ 271(b) and (c). A waiver of sovereign immunity must be strictly construed. Stated differently, the Government is not to be regarded as having waived its sovereign immunity by implication. Hence, we hold that 35 U.S.C. §§ 271(b) and (c) are not incorporated by implication in section 1498. It is our view that the Government has agreed under section 1498 merely to assume liability for its direct infringement of a patent; it has not agreed thereunder to assume liability for its active inducement of infringement or for its contributory infringement.[31]

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[30] It is clear that the use of the breadboards by the companies was not for and with the authorization of the Government. The use occurred prior to the Government's soliciting bids for its first contract for Omega receivers.

[31] In *Leesona Corp.* we made an observation which is equally apropos here:

"The fundamental error of the trial judge is that he has taken 28 U.S.C. § 1498, which is essentially an Act to authorize the eminent domain taking of a patent license, *** and he hs converted it to a consent to suit on a tort theory, and the

Decca appears to agree that 35 U.S.C. §§ 271(b) and (c) are not incorporated by implication in section 1498. Yet Decca contends that *Coakwell*[32] is authority for the proposition that the Government is liable for active inducement of infringment and contributory infringement. In support of its contention, Decca cites this language in *Coakwell:* "[Section 1498] was not intended to change the basic incidents to which liability would attach for the purposes of seeking comprehensive compensation for the unlicensed use of a patented invention."[33] Decca argues that the Court intended "the basic incidents to which liability would attach" to signify all incidents of liability applicable to private infringers, including active inducement of infringement and contributory infringement. Decca urges that, because section 1498 "was not intended to change the basic incidents," the section must contemplate governmental liability for active inducement of infringement and contributory infringement.

Decca misreads *Coakwell.* The "basic incidents" of liability to which the court was referring were incidents of direct infringement, specifically, the making or using of a patented invention. The court did not examine in *Coakwell,* to any extent, the propriety of holding the Government liable for active inducement of infringement or contributory infringement.[34]

For the reasons discussed above, we hold that the trial judge's determination that October 24, 1967, is the date the Government first became liable for infringement of the '816 is erroneous. The

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treatment of the United States as a tort-feasor. ***" *Leesona Corp.* v. *United States, supra* note 13, 220 Ct. Cl. at ___, 599 F.2d at 966.

Active inducement of infringement and contributory infringement sound in tort. They are descriptive terms for conduct which does not involve *the Government's* making or using a patented invention and thereby exercising its eminent domain power to take a patent license.

[32] *Coakwell* v. *United States,* 178 Ct. Cl. 654, 372 F.2d 508 (1967).

[33] *Id.,* 178 Ct. Cl. at 659, 372 F.2d at 511.

[34] In *Coakwell,* the court distinguished use of a patented invention from purchase of a patented invention. The court intimated, in dictum, that section 1498 does not impose liability on the Government for merely purchasing a patented invention.

liability of the Government first arose when it directly infringed the '816 for the first time. The record establishes the date of its first direct infringement to be June 1969. In June 1969, it used, for the first time, a system consisting of the four Omega IOC stations and a single receiver capable of lane-resolving in the manner taught by the '816.[35]

C. The Government's use of the AN/ARN-99(XN-1) receiver to receive and process the three-frequency Omega format being transmitted by the IOC stations in June 1969 constituted, as pointed out in the preceding section, the Government's first direct infringement of the '816.

The IOC stations provided radio navigation coverage of a geographic area substantially less then the entire world. Subsequent to its first direct infringement, the Government expanded both the geographic coverage of and the incidence of use of the Omega system. It accomplished the twofold expansion by integrating additional operational Omega transmitters into the system and by acquiring additional operational three-frequency receivers. Each time the Government integrated, prior to the expiration of the '816, an additional operational transmitter into the system, it engaged thereby in an additional direct infringement of the '816. Likewise, each time it acquired possession of, prior to the expiration of the '816, an additional operational three-frequency receiver, it engaged thereby in an additional direct infringement. With respect to each of its additional direct infringements, the Government is deemed to have taken a license in the '816, the license conferring rights to the Government commensurate with the particular direct infringement covered by the license.

As of July 22, 1975, the expiration date of the '816, the Government had not completed construction of four of the eight permanent Omega stations. As of the date in question, the four unfinished stations were not yet operational. Hence, the Government's pre-July 22, 1975, activities involving the four stations, in-

[35] The receiver was the AN/ARN-99(XN-1), an automatic three-frequency receiver.

cluding its acquisition of station electronics for them, did not amount to a direct infringement of the '816.[36]

The Government possessed, as of July 22, 1975, 38 operational three-frequency receivers.[37] In addition, as of the same date, the Government possessed numerous unassembled three-frequency receiver sets; and it had ordered, but had not received delivery of, other three-frequency receiver sets. Its possession of the unassembled sets and its order of the undelivered sets did not amount to a direct infringement of the '816 because, as of the date of expiration of the '816, these sets were not used or available for use in the system of operational Omega stations.

D. Fourteen of the operational three-frequency receivers which the Government possessed as of July 22, 1975, were AN/ARN-99(V)1's. Thirteen of these AN/ARN-99(V)1's were connected to general-purpose computers which could provide only a position readout, expressed in terms of latitude and longitude. Because the computers were not programmed to provide a hyperbolic LOP readout, the Government argues that the thirteen AN/ARN-99(V)1's connected to them were not similar to the AN/ARN-99 or the BRN-7, both of which can provide a hyperbolic LOP readout.

We disagree with the Government. Even though the computers could provide only a position readout, they determined position by lane-resolving in the manner taught by the '816. Specifically, through processing the Omega format transmitted by three stations, they determined two intersecting hyperbolic LOP's and then provided a readout of the point of intersection of the LOP's. The readout was expressed in terms of the latitude and longitude of the point of intersection. The readout, though not of a hyperbolic LOP, was the end-product of determining two such LOP's.[38]

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[36] As of the expiration date of the '816, the four stations were not available for use with an operational three-frequency receiver capable of lane-resolving.

[37] An operational receiver is a receiver the components of which have been assembled and made ready for use in assembled form.

[38] It should be noted that the AN/ARN-99 and the BRN-7 can provide a position readout, as well as a readout of a hyperbolic LOP.

IV.

A. Trial Judge Browne calculated the quantum of reasonable and entire compensation to which Decca is entitled, exclusive of delay compensation, as follows:

> According to [the Government's] own estimates, implementation of the worldwide eight transmitter Omega system would result in a cost saving to [the Government], alone, of $640 million over a 10-year period as compared with Loran-C, the best available noninfringing system. Prorated on an annual basis, the saving to [the Government] would be $64 million per year for the eight transmitter system. Half that figure ($32 million per year) would be reasonable to allocate to the four transmitter system. Applying that figure to the period from October 24, 1967 to July 22, 1975 (7 years, 9 months), the period during which the four transmitter system was in operation, the saving would amount to approximately $248 million. Applying to that figure a recovery factor of 20 percent * * * Decca would be entitled to the sum of $49.6 million. This figure, however, is subject to further adjustment to take into account the fact that the figures upon which it is based were only educated estimates used to stimulate congressional interest in funding the construction of the Omega system and were, no doubt, highly inflated. Therefore, it is believed to be proper to discount the figure by 50 percent in order to take into account the inflated nature of the original figures upon which the $49.6 million is based, thus reducing the net amount to $24.8 million. * * *

Thus, the trial judge used a cost savings method to calculate the value to Decca of the rights under the '816 taken by the Government.

The court has used a cost savings method of valuation in three previous patent infringement cases. In *Shearer* and in Olsson,[39] we used a cost savings method because the patents held to be infringed

[39] *Shearer* v. *United States* and *Olsson* v. *United States*, *supra* note 20.

in those cases had not been licensed commercially. In *Marconi Wireless Telegraph Co.* we used a cost savings method because "great difficulty" would have attended our determining a royalty base correspondent to the particular Marconi patent claim held to be infringed in that case.[40]

The factors which persuaded us to use a cost savings method in *Shearer, Olsson,* and *Marconi Wireless Telegraph Co.* are not present in this case. Decca has licensed commercially rights under the '816 which are similar to the rights thereunder taken by the Government.[41] The trial judge's findings of facts in this case, as modified by us, provide adequate means for our determining a royalty base correspondent to the rights under the '816 taken by the Government.

Defendant argues that Omega did not in fact displace defendant's use of Loran-C and points out that the alleged savings are speculative at best. No doubt Omega is an improvement over Loran-C just as Loran-A represented an advance in convenience over use of the alidade or dead reckoning, but we are not compelled to evaluate that possibility. The means exist in this case for a more conventional and substantiated measure of the liability legally incurred by defendant. That is all we are permitted to award, even though plaintiff might have obtained a larger amount if the infringer had not been the Government.

Because the reasonable royalty method is the preferred method of ascertaining the value of patent rights taken by the Government and because the facts of this case do not constrain us to use a method of valuation different from the preferred method, we decline to adopt the cost savings method by which the trial judge calculated his award of $24,800,000 basic compensation[42] to Decca;[43] and, therefore, we decline to adopt the award itself. We

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[40] *Marconi Wireless Tel. Co.* v. *United States, supra* note 20, 99 Ct. Cl. at 69.

[41] The Bendix license and the ITT/NSI license are two such commercial licenses.

[42] Basic compensation is reasonable and entire compensation exclusive of delay compensation.

[43] The propriety of our rejection of this cost savings method is buttressed by the trial judge's admission that the keystone of the method, namely, the Government's estimate of what its total cost savings over a 10-year period would be, was "highly

believe that it is necessary to use the reasonable royalty method to calculate the basic compensation to which Decca is entitled. Use of the reasonable royalty method involves a determination of a reasonable royalty base and a reasonable royalty rate.

B. To determine a royalty base reasonably correspondent to the scope of the Government's direct infringement of the '816, we have focused primarily on two issues: (1) whether the royalty base should include the entire cost of design and construction of an Omega transmitting station or only certain components of the cost; and (2) whether the royalty base should include the costs associated with the station electronics for the four unfinished permanent Omega transmitting stations and the costs associated with the unassembled three-frequency receiver sets in the possession of or ordered by the Government during the term of the '816. In addition to resolving these primary issues, we discuss below several miscellaneous matters pertinent to our determination of a reasonable royalty base.

1. Trial Judge Browne determined that it would be inappropriate to include in the royalty base the entire cost of design and construction of an Omega transmitting station:[44]

> 73. The cost of designing and constructing complete Omega *stations* includes the cost of items such as land, buildings for equipment[,] personnel, roads, prime power equipment, and diesel backup generators. The named items, however, are not part of the claimed invention of '816, nor are they items which must be specially created to utilize the '816 invention. The building used to house the helix, however, is specially designed and constructed for use in the infringing system. Accordingly, that part of the cost of

inflated." The unreliability of the estimate was underscored by the trial judge's determination that it should be discounted by 50 percent. Both the discount rate and the percentage of discounted cost savings awarded (20 percent) appear to be arbitrary.

[44] Cognizant that the court might reject his cost savings approach, the trial judge discussed in some of his findings of fact the reasonable royalty method of appraising the rights under the '816 taken by the Government.

> designing and constructing the Omega stations attributable to design and construction of land, buildings for equipment (except the helix building) and personnel, road, prime power equipment, and diesel backup generators are excluded from computation of the base. [Emphasis in original.]

In the view of the trial judge, Decca itself recognized the propriety of these exclusions from the royalty base by agreeing to their incorporation in the definition of transmitter contained in the Bendix license. Excluded from the meaning of transmitter, as the term was defined in that license, were virtually the same items which the trial judge determined to warrant exclusion from the royalty base here.

In effect, then, the trial judge regarded the definition of transmitter in the Bendix license as delineating a dividing line between components of the cost of an '816-type transmitting station to be included in a royalty base and components thereof to be excluded. The Government concurs in the trial judge's view of the import of the definition and in his determination, through use of the definition as a guidepost, of which components of the cost of an Omega station[45] are to be excluded from the royalty base here.[46] Decca, on the other hand, advances a different view of what the significance of the definition is; and it urges the court (a) to repudiate the trial judge's use of the definition as a guidepost for determining the royalty base and (b) to adopt a royalty base which includes the entire cost of an Omega station.[47]

Decca assails on two grounds the trial judge's use of the definition as a guidepost. First, it points out correctly that the Bendix

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[45] We use "Omega Station" and "Omega transmitting station" interchangeably.

[46] The components which the trial judge and the Government would include in the royalty base are as follows: the cost of procurement and installation of station electronics, including the cost of design and construction of the station antenna; the cost of procurement and installation of electronic shielding for the helix building; and the costs for structural elements associated with the antenna.

[47] Decca did not except, however, to any of the trial judge's fact findings in which his view that it is inappropriate to include in the royalty base the entire cost of an Omega station is set forth.

license did not convey any right pertaining to an Omega-type embodiment of the '816. The rights conveyed in the Bendix license related exclusively to Decca Navigator systems, including the Mk X, and to Dectra systems. Second, Decca contends (a) that, because the "license to Bendix * * * included a limited definition of transmitter which did not include the entire system," the license did not convey the right to "build and operate" an entire Decca Navigator or Dectra system; and (b) because this is so, the rights granted in the Bendix license were narrower in scope than the rights which the Government took for the purpose of establishing the Omega system. The conclusion which Decca seems to draw from its premises (a) and (b) is that it is entitled to a royalty base here which is broader than the definition of transmitter in the Bendix license because the scope of the rights taken by the Government is broader than the scope of the rights conveyed in that license.

Although the Bendix license did not convey any right pertaining to an Omega-type embodiment of the '816, the license did convey rights involving the Mk X system. The Mk X system is an embodiment of claims 1 and 11 of the '816.[48] By Decca's own admission, the Mk X system is "conceptionally [the] same" system as Omega and "the technical problems in the erection of the [Mk X] system were substantially the same" problems encountered by the Government in erecting Omega. Hence, the Bendix license concerned a navigation system which is substantially similar to Omega, *i.e.*, the Mk X system.

Decca's contention that the Bendix license did not convey the right to build and use a complete Mk X system or any other Decca Navigator or Dectra system[49] is untenable. As indicated earlier, Decca bases this contention on its view that the limited definition of transmitter contained in the Bendix license was intended to confine the transmission-related subject matter to which the rights

[48] It is recalled that Omega is an embodiment of claims 1, 4, and 11 of the '816 and that, of the three claims, claim 1 is the only independent claim.

[49] Decca's corollary to this contention is that it reserved this right for itself.

conveyed in the license were applicable to the technical equipment providing the transmission service. This view of the intendment of the definition is, in our opinion, erroneous.

We believe that the definition was intended merely to limit the scope of the royalty base under the license. We derive our belief, in part, from evidence of record which indicates that the definition was included at the insistence of the Bendix Corporation. Hence, it appears to us that the impetus for the inclusion of the definition was a concern by Bendix that, in the absence of such a definition, Decca might attempt to charge a royalty on the entire price of a Decca Navigator or Dectra system built and sold by Bendix.

Our view that the definition was not intended to preclude Bendix from building and using a complete system is reinforced by two other considerations. First, the Bendix license conveyed *in unqualified terms* the right to use transmitters and receivers. In other words, the license imposed no restriction on this right. Hence, this right must have included the right to combine transmitters and receivers into an operational system. Such a combination was the natural and likely use to be made of transmitters and receivers covered by the license.[50] Second, the license granted to Bendix the "exclusive" right to make and use transmitters and receivers. "Exclusive" was defined in the license as follows:

> * * * "Exclusive" shall mean, as applied to any rights granted herein, that neither the grantor nor any other person other than the grantee shall exercise such right.

Hence, any combining of transmitters and receivers into a system was achievable only through Bendix.[51]

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[50] Of course, the right to use transmitters and receivers by combining them into an operational system was, in effect, the right to make an operational system.

[51] The holdings which we have made up to this point can be summarized as follows. The Bendix license did convey the right to build and use complete Decca Navigator and Dectra systems, including the Mk X. The royalty base under the license did not include the entire price of such systems. Both the conceptual nature of and the incidents characterizing the use of the Mk X-related rights conveyed in the Bendix license were substantially similar to the conceptual nature of and the incidents characterizing the use of the rights taken by the Government with respect to Omega.

In conjunction with urging the court not to use the Bendix license definition of transmitter as a guidepost for determining the royalty base here, Decca asserts that "the entire market value rule" requires the court to fashion a royalty base which includes the entire cost of design and construction of an Omega station. Decca justifies this assertion as follows:

> When one looks at the entire market value in the case at bar, * * * one sees an unusually large and sprawling conglomeration of separate parts which make up the system. On the other hand, even though they may be widely separated physically, each contributes to the system as a whole, * * * and, in fact, each part performs a necessary function. For example, * * * [t]he station cannot be built without the roads to transport the heavy equipment. The helix and transmitters, if continuous operation is expected, must be housed. The personnel also must be housed. Utilities are also required. The environment of the transmitters and coils must be controlled. * * * In a nutshell, everything at the transmitting and monitoring stations is at least "reasonably" necessary or else it would not be procured, and if the Omega system had not been built, none of those items would have been procured or located at remote places of the world where they exist today * * * * * *

Decca misapprehends the entire market value rule. The rule is a judicially fashioned directive that, in certain instances, unpatented items used in combination with a patented invention are to be included in the royalty base for the invention. The directive applies only if the invention has substantially created the value of the items, *i.e.*, the sole utility of the items consists in their being used in combination with the invention.[52] With respect to the Omega station items excluded by the trial judge from the royalty base here, the stated prerequisite to the applicability of the directive is absent. The land, buildings, roads, and other items excluded by the trial judge would have substantial utility and value

[52] *See Tektronix, Inc.* v. *United States*, 213 Ct. Cl. 257, 272, 552 F.2d 343, 351 (1977).

even if all transmitting apparatus at an Omega station were dismantled and removed from the station. In short, the excluded items are susceptible of uses not involving the '816; and their value derives, at least in part, from this potential for other uses. Hence, the entire market value rule does not require that the items excluded by the trial judge be included in the royalty base.

In addition to invoking the entire market value rule to justify a royalty base which includes the entire cost of design and construction of an Omega station, Decca contends that, because it "normally would expect to sell such systems [as Omega] in their entirety as 'turn key' jobs," it is entitled to a royalty base which "correspond[s] to a reasonable open market, retail price for the system as a whole."[53] Decca's contention is, in effect, an attempt to recover vicariously, by means of an inflated royalty base, damages for the loss of business opportunity which Decca alleges to have suffered because of the Government's decisions (1) to establish Omega and (2) to act as its own prime contractor for this purpose. In Decca's view, the first decision precluded Decca from selling an Omega-type system to anyone other than the Government and decision (2) precluded it from selling Omega to the Government.

An insuperable obstacle to this attempt by Decca to recoup its alleged loss of business opportunity is that 28 U.S.C. § 1498 (1976) does not mandate compensation for such loss. In *Leesona*, we made an observation which is apropos here:[54]

> * * * Plaintiff's evidence placed scant emphasis on the actual value of the infringed patents to [plaintiff], which is what we must determine under § 1498, and more on the total loss suffered by the entire corporation as a consequence of losing both the exclusive domestic manufacturing rights and the procurement contract * * *. Just compensation in

[53] Decca asks the court to calculate the "open market, retail price for the system as a whole" by estimating what Decca would have charged the Government to build and demonstrate the operability of the entire Omega system, including the four IOC stations and the eight permanent stations.

[54] *Leesona Corp.* v. *United States*, *supra* note 13,220 Ct. Cl. at __, 599 F.2d at 972-73.

> eminent domain does not recompense such injury. * * * [T]he tort theory under which such injury might be compensable was not applicable in a § 1498 taking case. There is a difference between evaluating the value of the property taken in light of plaintiff's business needs, and granting compensation for loss of business due to the taking, or for any incidental losses. The former is proper, the latter is not. *Gulf Refining Co.* v. *United States*, 58 Ct. Cl. 559, 577 (1923). That case neatly illustrates the proposition. The property taken was tank steamers; plaintiff was an oil company; business injury to plaintiff was not for consideration, * * *.

Decca is entitled under section 1498 to a royalty base reasonably correspondent to the portion of the planned Omega system which was operable as of July 22, 1975, *i.e.*, to a royalty base reasonably correspondent to the scope of the Government's direct infringement of the '816, the scope being measured as of the date the '816 expired. A royalty base corresponding to a retail price for the entire planned Omega system would exceed on a massive scale the base just described. Our using such an inflated base would be tantamount to our awarding Decca the profit which it would have made had it been able to capitalize on its once-existing opportunity to sell an Omega-type system. Because section 1498 does not mandate compensation for the loss of this or any other business opportunity, it would be improper for us to use the inflated base in question.[55]

Finally, we believe that Decca's having agreed to inclusion in the Bendix license of the limited definition of transmitter discussed

[55] Even if we were able to consider the merits of Decca's loss of business opportunity claim, we would be confronted with two seemingly intractable issues: (1) the extent, if any, to which the Government, had it lacked the eminent domain power to take patent rights, would have established an Omega system; and (2) the extent, if any, to which persons other than the Government would have established an Omega-type system had the Government chosen either (a) not to establish Omega or (b) to establish an Omega system providing less than worldwide coverage.

heretofore is a reliable indication that, had Decca and the Government negotiated a patent license authorizing the Government to establish Omega, Decca would have agreed in such a license to a royalty base from which was excluded the same items excluded from the definition of transmitter in the Bendix license. A royalty base fashioned in this manner is, we believe, reasonable. Therefore, we adopt the trial judge's determination of which components of the cost of an Omega station are to be excluded from the royalty base.

2. We turn now to the issue whether the royalty base should include the costs associated with the station electronics for the four unfinished permanent Omega stations[56] and the costs associated with the three-frequency receiver sets which, during the term of the '816, the Government had ordered but had not received or had not assembled and made operable. The trial judge determined that all these costs should be included in the royalty base. He justified their inclusion as follows:

> * * * Since all of defendant's activity in the procurement of equipment for transmitting stations and three-frequency receivers up to July 22, 1975 was intended for use in the infringing Omega system, such procurement was contributory to, or actively induced the infringement; hence, such procurement is includable in the compensation.

The validity of the trial judge's justification pivots on the validity of the following syllogism. (1) By contracting to supply the Government with the station electronics for the four unfinished stations and with the three-frequency receiver sets in question and by being aware that the Government intended to integrate these items into an already existing Omega system, the Government's suppliers engaged in contributory infringement. (2) The Government is liable under section 1498 for the contributory infringement of its suppliers. (3) Therefore, the royalty base must include the station electronics and three-frequency receiver sets in question,

[56] It is recalled that, as of the expiration date of the '816, the Government had let contracts for procurement of all the station electronics in question and had received delivery of most of these electronics.

these items having been the subject of contributory infringement by the Government's suppliers. If this syllogism is valid, we must affirm the trial judge's inclusion of these items in the royalty base.

The syllogism is invalid because the second premise thereof is erroneous. Section 1498 does not render the Government liable for the "contributory infringement" of its suppliers. The section waives the Government's sovereign immunity only with respect to governmental direct infringement of a patent.[57] Because the station electronics and three-frequency receiver sets in question had not been made operable as of the date of expiration of the '816, they were not involved in the Government's direct infringement of the '816.[58] Because they were not involved in the Government's direct infringement, they cannot be included in the royalty base. To include them would be to award Decca compensation for the "contributory infringement" of the Government's suppliers. This we are not empowered to do, the Government's sovereign immunity remaining a bar to such an award.[59]

3. Having resolved the primary issues, we focus now on several miscellaneous matters. First, the Government excepts to the trial judge's inclusion in the royalty base of 60 single-frequency receivers which Decca alleges it would have used to monitor and calibrate the Omega system had it been engaged by the Govern-

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[57] These principles are discussed more thoroughly in sections II and III B of this opinion, *supra*.

[58] It should be noted that the four unfinished stations were being built for the purpose of expanding the geographic coverage of the Omega system, rather than for the purpose of assisting in the maintenance of the scope of coverage which the system provided as of July 22, 1975. Hence, the four unfinished stations cannot he included in the royalty base pursuant to any theory commending inclusion of spare parts.

[59] Moreover, premise (1) of the syllogism is of doubtful validity. Contributory infringement is a generic term for conduct which contributes to the enlargement of an already existing direct infringement. Only because the direct infringement is tortious is the conduct contributory to it tortious. Hence, absent a tortious direct infringement, there can be no contributory infringement.

The Government's "direct infringement" of a patent is not tortious because the Government is deemed to have taken a license in the patent authorizing its direct infringement. Thus, governmental suppliers can be said not to be guilty of contributory infringement insofar as this term connotes tortious conduct.

ment to build and demonstrate the operability of the system. The Government's exception has merit. There is no evidence of record indicating the identity or quantity of what *the Government* used to monitor and calibrate the system. What the Government actually used for this purpose, not what Decca would have used, is the relevant issue. Hence, we do not include the 60 single-frequency receivers in the royalty base.

Second, we include in the royalty base a portion of the cost which the Government incurred to develop software for the BRN-7. The portion we include has been calculated by multiplying the cost by the fraction 18/97. The numerator of the fraction is the number of BRN-7 sets assembled and made operable by the Government during the term of the '816. The denominator is the number of BRN-7 sets ordered by the Government during the term of the '816. Because the software development cost is "directly reflected in the fair market value" of the BRN-7, it is not the type of cost which the R&D exclusion in the Bendix license would have covered.

Third, we do not include in the royalty base the cost of the "first article" testing of BRN-7's. Because this cost is not "directly reflected in the fair market value" of the BRN-7, it is the type of cost which the R&D exclusion in the Bendix license would have covered.

Fourth, we include in the royalty base a portion of the cost of the general-purpose computers to which were connected the AN/ARN-99(V)1's made operable by the Government during the term of the '816. We have calculated the portion by using a method suggested by the Government. The Government suggested the method when it stated:

> * * * [B]y subtracting the price of an OR-90/ARN-99(V) receiver-converter, which has no computer ($15,653), from the price of an OR-133(V)(2) URN receiver-computer set for an AN/ARN-99(V)4 set which does ($50,258), a difference of $34,605 is derived which represents a reasonable portion of the cost [of] the aircraft's central computer.

4. Guided by the foregoing analysis, we have determined that a reasonable royalty base is $27,245,679. We present in Appendix B how we have computed this amount.

C. Having determined the base, we must now find the appropriate royalty rate. In the course of discussing the Bendix license in one of his findings of fact, Trial Judge Browne stated: "if the Government obtained a license from Decca or a sublicense from Bendix prior to litigation, the 7.5 percent royalty rate [in the Bendix license] would have been an established reasonable royalty rate."[60] In another of his findings of fact, the trial judge stated: "[i]f compensation is to be based on a reasonable royalty applied to the full market value of the system as it existed from October 24, 1967 to July 22, 1975, a royalty rate of 10 percent is adequate for the case at bar."[61] The only logical explanation for the trial judge's adding 2.5 percent to the "established reasonable royalty rate" of 7.5 percent is that (a) he believed that Decca is entitled under 28 U.S.C. § 1498 (1976) to recoup the cost which it is incurring to litigate this action and (b) he intended the 2.5 percent rate increment to be the means of effectuating the recoupment.

This court has held, however, that section 1498 authorizes neither a direct recovery of litigation expenses[62] nor their recovery by vicarious means, *e.g.*, augmenting a commercial royalty rate which has been set at fair market value.[63] Because the trial judge must be regarded as having determined in the second quoted finding of fact that 10 percent is a reasonable royalty rate *if* Decca's litigation expenses are to be considered in computing the rate and because the measure of recovery prescribed in section 1498 excludes consideration of litigation expenses, we have declined to adopt the second quoted finding of fact. We begin our determination of a reasonable royalty rate by focusing on the 7.5 percent royalty rate in the Bendix license, the trial judge having found that

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[60] Trial judge's finding of fact No. 127.

[61] Trial judge's finding of fact No. 59.

[62] *Leesona Corp.* v. *United States*, *supra* note 13, 220 Ct. Cl. at ___, 599 F.2d at 970.

[63] *Calhoun* v. *United States*, *supra* note 17, 197 Ct. Cl. at 56, 453 F.2d at 1394.

this rate represented "prior to litigation, * * * an established reasonable royalty rate."

The Government has excepted to this finding. The Government contends that a 7.5 percent royalty rate would be too high. It supports its contention with four arguments. First, it asserts that the ITT/NSI license, in which Decca agreed to a 5 percent royalty rate for Omega equipment,[64] is more probative of a reasonable royalty rate than is the Bendix license.[65]

Not only do we disagree with this assertion, we conclude that its converse is true, *i.e.*, that the Bendix license is more probative of a reasonable royalty rate than is the ITT/NSI license. Our conclusion stems from the following considerations. Because the Government announced its project to establish the Omega system and because the project required the Government to engage in more than one taking of rights under the '816, the time as of which we must appraise the patent rights taken by the Government is the date the Government announced the project.[66] This date is June 1965. Hence, the value which we must ascribe to the taken patent rights is their value as of June 1965.

The Government's announcement of the Omega project precipitated a decline in the fair market value of the Omega-

[64] This rate was to decrease, upon the happening of certain events, to 2.5 percent.

[65] The Government propounds two justifications for this assertion: (1) In the ITT/NSI license, Decca conveyed rights under the '816 which related specifically to Omega. No right conveyed in the Bendix license related specifically to Omega. (2) "[T]he ITT license indicates the relative valuation of patent and know-how rights. The ITT license indicates that 2.5 percent of the royalty rate is for know-how and 2.5 percent is for patents." The Bendix license, on the other hand, contains no indication of the relative valuation of the patent and know-how rights which were conveyed in it.

The first justification is factually correct. The factual correctness of the second justification is arguable. Even assuming that the second justification is factually correct, both justifications lack persuasiveness. They lack persuasiveness because, as explained hereafter in the text of this opinion, the ITT/NSI license was negotiated at a time when the fair market value of the Omega-related rights under the '816 was substantially less than what it had been at the time as of which we must appraise the patent righs taken by the Government.

[66] *See United States* v. *Miller*, *supra* note 18.

related rights under the '816.[67] The decline was attributable to the following factors. Because Omega was to provide worldwide radio navigation coverage, no other system of its kind was needed. Because no other system of its kind was needed, the Government was the only buyer or maker of such a system. Because of its eminent domain power and section 1498, the Government was under no legal constraint to negotiate with Decca for a patent license authorizing it to establish Omega. Because section 1498 shields governmental contractors from being held liable for contributory infringement,[68] contractors supplying Omega components to the Government or contributing in any other way to the construction of Omega were not required to obtain from Decca a license authorizing these activities.

The net effect of the aforementioned factors was to erode, almost completely, Decca's entitlement to monopoly control of the market for Omega-type systems.[69] Because the Omega-related rights under the '816 were the source of this entitlement and because their fair market value was attributable to the fact that they provided this entitlement, the erosion of the entitlement gave rise to a correspondent decline in their fair market value. By March 31, 1969, the date of execution of the ITT/NSI license, the decline had become substantial.

The royalty rate for Omega equipment which was negotiated in the ITT/NSI license reflected this decline.[70] The rate was, in short, substantially less than what it would have been had it been negotiated immediately prior to the Government's June 1965 an-

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[67] By "Omega-related rights under the '816," we mean the rights under the '816 which related to an Omega-type embodiment of the '816.

[68] *See Leesona Corp.* v. *United States*, *supra* note 13.

[69] As stated in the text, the erosion was not complete. Not only did the Omega project not impair Decca's monopoly control of licensings or sales of three-frequency receivers to potential nongovernmental users of Omega-type systems, the Omega project might have increased the opportunities for such licensings or sales. However, the potential for the licensings or sales in question constituted a relatively minor component of the market for Omega-type systems.

[70] In the language of the trial judge, the rate was "depressed."

nouncement of the Omega project. Because of this fact and because the value which we must ascribe to the rights under the '816 taken by the Government is their value as of the June 1965 announcement, a reasonable royalty rate for the case at bar must be substantially higher than the royalty rate for Omega equipment in the ITT/NSI license.

Hence, the ITT/NSI license is not a reliable indicium of what is a reasonable royalty rate. The Bendix license, on the other hand, is. It was negotiated before the decline in the fair market value of the Omega-related rights under the '816 began.

The second argument which the Government makes to support its contention that a 7.5 percent royalty rate would be too high is that, unlike the Bendix license, the patent license taken by the Government was not exclusive. This alleged distinction is significant, according to the Government, because the royalty rate for an exclusive license in a patent is, ordinarily, higher than the royalty rate for a nonexclusive license in the same patent.

It is true that the patent rights taken by the Government were not exclusive in a legal sense. The Government was not entitled to exclude anyone else from establishing an Omega-type system. However, because Omega was to provide worldwide radio navigation coverage, there was no need for another system of its kind. That anyone else would have chosen to incur the cost of establishing a system duplicative of Omega was extremely unlikely. Hence, the patent rights taken by the Government were, practically speaking, exclusive.[71]

The third argument which the Government makes to support its contention that a 7.5 percent royalty rate would be too high is that the royalty rate in the Bendix license would have been less than 7.5 percent had that license conveyed rights merely in the '816.[72] The short answer to this argument is that the '816 was the

[71] Our conclusion harmonizes with the trial judge's fact-finding that the patent license taken by the Government was the "equivalent of an exclusive license."

[72] It is recalled that the Bendix license, in addition to conveying rights in the '816, conveyed rights in 60 other patents and in Decca's know-how concerning the 61 licensed patents. The know-how having been technical information pertaining to the 61 licensed patents, the granting of rights in the know-how was ancillary to the granting of rights in the patents.

most valuable patent included in the Bendix license and, therefore, had Decca and Bendix negotiated a license in it alone, the royalty rate for such license would have been at least 7.5 percent.[73]

Finally, the Government argues that, because "over *90%* of the [Government-owned] receivers using the Omega system were 10.2 kHz [single-frequency] receivers—*which do not infringe* when combined with Omega transmitters" (emphasis in original), it is appropriate "to scale down the [7.5 percent] royalty rate [in the Bendix license] to take into account" this noninfringing use of the Omega system. For two reasons, we do not concur in this argument. First, only after a single-frequency receiver had been "initialized" through use of the full three-frequency Omega format could that receiver determine its position by receiving the 10.2 kHz Omega frequency. Second, the Mk X system, the Bendix license royalty rate for which was 7.5 percent, appears to have been susceptible of a use with single-frequency receivers which was similar to the aforementioned use of Omega with single-frequency receivers.

Having considered the Government's arguments on the issue of what is a reasonable royalty rate, we turn to Decca's position on the issue. Decca contends that a 7.5 percent royalty rate would be too low. It bases its contention on the fact that the Mk X system was in direct competition with the Loran-C system. Decca argues that the 7.5 percent Bendix license royalty rate for the Mk X system was lower than what it would have been had the Mk X system not been in competition with another system.[74] Decca's corollary to this argument is that, because Omega was not in competition with another system, a reasonable royalty rate for the case at bar must be higher than 7.5 percent.

It is true that the Mk X system was in direct competition with the Loran-C system, whereas Omega was not in competition with another system. However, we regard this distinction as being offset by another distinction, namely, whereas Decca incurred

[73] An observation which we made in *Leesona* is pertinent here: "[T]he number of patents involved in a licensing agreement is not the material factor in determining the license's worth; it is the value of the rights embodied in those patents." *Leesona Corp.* v. *United States*, *supra*, note 13, 220 Ct. Cl. at ___, 599 F.2d at 976.

[74] The rationale underlying this argument can be stated as follows: Competition eventuates in smaller profits; smaller profits necessitate a smaller royalty rate.

substantial R&D costs with respect to the Mk X system, it incurred no R&D costs with respect to Omega. The fact that it incurred no R&D costs with respect to Omega would tend to lower a royalty rate for Omega by approximately the same amount as the fact that Omega was not in competition with another system would tend to raise such a rate.

In conclusion, we hold that a royalty rate of 7.5 percent is reasonable for the case at bar.

V.

With regard to the IOC Omega stations, we calculate delay compensation from June 16, 1969.[75] With regard to the permanent Omega stations included in the royalty base, we calculate delay compensation from the dates on which these stations became operational in the three-frequency Omega mode. With regard to the three-frequency receivers assembled and installed during the term of the '816, we calculate, with one exception, delay compensation from the January 1's of the fiscal years in which the receivers were installed.[76] With regard to the spare parts allocable to the Omega system which was operational as of July 22, 1975, we calculate delay compensation from July 4, 1972, an approximate midpoint of the period June 16, 1969-July 22, 1975.[77] Our calculations of delay compensation are presented in Appendix C.

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[75] All four IOC stations were operational in the three-frequency Omega mode as of this date. The date is an approximate midpoint of the month in which the Government operated, for the first time, a receiver capable of lane-resolving in the manner taught by the '816. The record before us does not indicate the particular June day on which the Government first operated the receiver (the ARN-99(XN-1)). We deem the first day of operation to be June 16.

[76] The exception concerns the ARN-99(XN-1)'s. We calculate delay compensation for them from June 16, 1969 (rather than from January 1, 1969). For the other receivers, we use the January 1's of the fiscal years in which they were installed because the trial judge found that "[g]enerally, the * * * installation instances occurred in the latter half of the fiscal year."

[77] There is ample authority for our use of a midpoint: *Amerace Esna Corp.* v. *United States supra* note 19; *Calhoun* v. *United States, supra* note 17.

CONCLUSION OF LAW

Decca is entitled to $2,043,425.92 basic compensation. It is entitled to $1,131,033.49 delay compensation through June 30, 1980, plus additional delay compensation of $446.65 per day from July 1, 1980, to the day of payment of the judgment.[78] Judgment is entered accordingly.

APPENDIX A

The claims read as follows:

1. A hyperbolic radio navigation system in which a position line is determined by indicating the difference in the time of propagation to a receiver of signals emitted from two stations in known spaced geographical positions,

wherein three signals are emitted from a first station satisfying the respective phase conditions, given in radians of angle, $n_1 w_0 t + \alpha_1$, $n_2 w_0 t + \alpha_2$ and $(n_1 + 1) w_0 t + \alpha_3$, and three signals are emitted from the second station satisfying the respective phase conditions $n_1 w_0 t + k$, $n_2 w_0 t + \alpha_2 + k$ and $(n_1 + 1) w_0 t + \alpha_3 + k$, where n_1 and n_2 are integers, w_0 is 2π multiplied by a fundamental frequency in cycles per second, t is time in seconds and α_1, α_2, and α_3 and k are constants.

the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other station, and

the transmission being distinctively altered periodically for synchronising switching means at the receiver with the switching of the transmissions and

wherein the receiver comprises means for receiving the radiated signals,

switching means which are synchronised by the distinctive alteration in transmission and which are arranged to separate the received signals from the two transmitters, and

---

[78] The per day amount has been calculated on the basis of 1980 being a leap year. Hence, the amount applies only to days in 1980.

a phase difference indicator for indicating the difference in time of propagation which indicator has a recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental frequency,

said indicator being operated by a fine control and a coarse control,

said fine control being dependent on a pair of signals derived from locally generated non-interrupted signals, one of which is phase-controlled by only one of the signals received from said first station and the other by only one of the signals received from said second station and the coarse control being dependent on six received signals, derived from the three different frequencies transmitted from each of the stations.

* * * * *

4. A hyperbolic radio navigation system as claimed in claim 1 wherein, at each station, the various different frequencies are radiated in sequence.

* * * * *

11. A hyperbolic radio navigation system as claimed in claim 1 wherein there is provided a third transmitting station radiating signals satisfying the respective phase conditions given in radians of angle, $n_1 w_0 t + \alpha_1 + k_1$, $n_2 w_0 t + \alpha_2 + k_1$, $(n_1 + 1) w_0 t + \alpha_3 + k_1$ where k_1 is a constant,

the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other stations, and

wherein the receiver is provided with two of said phase difference indicators,

one indicator being arranged to indicate the difference in time of propagation of signals from the first and the second stations and the other being arranged to indicate the difference in time of propagation of signals from the first and third stations.

[The format of the claims has been changed for easier reading and understanding.]

APPENDIX B

Calculation of Royalty Base

A. Transmitters Used in Infringing Combination.

Station	Station Electronics (Components)	Station Electronics (Installation Cost)	Station Construction Cost Within Bendix License Definition of Transmitter	Total
1. IOC Stations				
Hawaii	$ 562,301	(Included in components)	0	$ 562,301
Forrestport	620,151	"	$ 30,000	650,151
Norway	569,940	"	1,119,783	1,689,723
Trinidad	658,656	"	839,701	1,498,357
IOC Stations Total	$2,411,048		$1,989,484	$4,400,532
2. Permanent Stations				
North Dakota	$1,275,165	$ 407,300	$3,275,607	$4,958,072
Norway	1,275,165	269,900	2,145,984	3,691,049
Hawaii	1,275,165	509,900	3,595,756	5,380,821
Japan	1,275,165	407,300	3,275,607	4,958,072
Permanent Stations Total	$5,100,660	$1,594,400	$12,292,954	$18,988,014
Grand Total—All Stations				$23,388,546

Calculation of Royalty Base - (Cont'd)

B. Receivers Used in Infringing Combination.

2 AN/ARN-99(XN-1)'s	$358,318
2 AN/ARN-99(XN-2)'s	197,430
14 AN/ARN-99(V)1's	798,696
2 AN/ARN-99(V)4's	120,798
18 AN/BRN-7's	981,179
38 Set Total	$2,456,421

C. Allocable Parts.

(1) Transmitters

AN/FRN-30	4/8 X $636,955	$318,478
AN/FRQ-18(V)	4/8 X $660,403	330,202
AN/FRT-88	4/8 X $572,703	286,352
Allocable Spare Parts Total		$935,032

Calculation of Royalty Base - (Cont'd)

C. Allocable Parts (Cont'd)

(2) Receivers

AN/ARN-99(XN-1) and AN/ARN-99(XN-2)		$48,393
AN/ARN-99(V)1		0
AN/ARN-99(V)4	2/20 X $23,444	2,344
AN/BRN-7	18/97 X $2,236,082	414,943
Allocable Receiver Parts Total		$465,680
Total Allocable Additional Parts		$1,400,712

D. Summary

From A, Transmitters	$23,388,546
From B, Receivers	2,456,421
From C, Allocable Parts	1,400,712
GRAND TOTAL FOR ROYALTY BASE	$27,245,679

Rate		Base		Basic Compensation
7-1/2%	X	$27,245,679	=	$2,043,425.92

APPENDIX C

Calculation of Delay Compensation

From June 16, 1969, through June 30, 1980:

	Number of Years	X	Percentage	X	Accrued Royalty		
6/16/69-12/31/70	1.545		0.065		$356,913.75	=	$35,843.06
	(for IOC stations and 2 ARN-99(XN-1)'s)						
1/ 1/71- 7/ 3/72	1.505		0.075		371,721.00	=	41,958.01
	(for the above + 2 ARN-99(XN-2)'s)						
7/ 4/72- 9/30/72	0.243		0.075		476,774.40	=	8,689.21
	(for the above + total allocable parts)						
10/ 1/72-12/31/72	0.252		0.075		848,629.80	=	16,039.10
	(for the above + North Dakota permanent station)						
1/ 1/73-12/19/73	0.967		0.075		852,908.55	=	61,857.19
	(for the above + 1 ARN-99(V)1)						
12/20/73-12/31/73	0.033		0.075		1,129,737.20	=	2,796.10
	(for the above + Norway permanent station)						
1/ 1/74-12/31/74	1.0		0.075		1,142,573.40	=	85,693.01
	(for the above + 3 ARN-99(V)1's)						
1/ 1/75- 1/14/75	0.038		0.075		1,268,008.90	=	3,613.83
	(for the above + 10 ARN-99(V)1's, 2 ARN-99(V)4's, 18 BRN-7's)						
1/15/75- 4/29/75	0.288		0.075		1,671,570.50	=	36,105.92
	(for the above + Hawaii permanent station)						

Calculation of Delay Compensation - (Cont'd)

1. From June 16, 1969, through June 30, 1980 - (Cont'd)

	Number of Years	X	Percentage	X	Accrued Royalty		
4/30/75–12/31/75	0.674 (for the above + Japan permanent station)		0.075		$2,043,425.92	=	$103,295.17
1/ 1/76– 6/30/80	4.497		0.080		2,043,425.92	=	735,142.89
							$1,131,033.49

2. From July 1, 1980, to Payment of Judgment:

(Percentage (0.08 X $163,474.07 Accrued Royalty) $2,043,425.92) + Days + 366 + 366 = $446.65 per day[1]

[1] This per-day amount has been calculated on the basis of 1980 being a leap year. Hence, the amount applies only to days in 1980.

IN THE UNITED STATES COURT OF CLAIMS

No. 299-70

DECCA LIMITED

v.

THE UNITED STATES

Robert B. Russell, attorney of record, for plaintiff. *Henry C. Nields* and *Russell & Nields*, of counsel.

John J. Fargo, with whom was *Assistant Attorney General Alice Daniel*, for defendant. *B. Frederick Buchan, Jr.*, and *Vito J. DiPietro*, of counsel.

Before NICHOLS, *Judge*, Presiding, KASHIWA and SMITH, *Judges*.

ORDER

In *Decca Limited* v. *United States*, No. 299-70, decided November 19, 1980, we stated that we adopted, with corrections, the findings of fact of Trial Judge Browne. Since the facts necessary to our ultimate determination of the case were incorporated into the opinion, we did not print the findings. Discussion of necessary changes in the findings would cause confusion if printed with the text of the opinion. Therefore, we set forth below in this order our modifications to and deletions from such findings.

Fact statements in the opinion not having counterpart in the findings may be taken as additional findings of the court. The following of the trial judge's findings of fact (FOF) are modified, or disapproved and deleted, as indicated:

FOF No. 24

This finding is corrected to read as follows:

24. The '816 patent relates to a hyperbolic radionavigation system wherein transmitter systems at two or more locations each emit three harmonically related signals which are received by a receiver capable of analyzing the three frequencies and of indicating the geographic position of the receiver.

FOF No. 25

Delete the words "developed and" from the first sentence.

FOF No. 26

Change the first word of the sixth line to "AN/FRN-30."

FOF No. 31

Substitute "Radux-Omega" for the word "RADUX."

FOF No. 37

Modify the last sentence to read as follows:

By establishing Omega as a "ANM-Designated Project," defendant undertook the role of "prime contractor" for the Omega project.

FOF No. 38

Eliminate entirely.

FOF No. 41

This finding is changed to read as follows:

41. Defendant began seeking bids for three frequency transmitter component design as a consequence of the successful tests in February 1966, and by June 1966 was soliciting bids for three frequency *receivers* from as many as 18 manufacturers. Captain Polk testified that six companies had made bread-board *receivers* "in anticipation of the contract we [the United States] put out." Since defendant's three frequency receiver solicitation started in June 1966, the companies which built the "bread boards" must have done so well prior to June 1966. The use of those "bread boards," together with three frequency Omega format signals from Trinidad, was sufficient to accord operational capability to the patented method of Omega signal processing even though the signals were being transmitted from that one station only. Since the signals from additional stations are a mere duplication of those from any other station (but for the differences in phase due to differences in distance), signals from a single station can be compared to those of a stable oscillator simulating a second station to illustrate how the system will work. By

September 30, 1967, defendant was operating a bank of three single frequency receivers, which were set up to receive the Omega signals. By manual (human) processing of the data provided by the receiver bank, the position of the receiver bank could be determined. Neither a phase indicator nor a mechanical equivalent thereof was a component of the receiver bank.

FOF No. 44

Eliminate last three sentences.

FOF No. 45

Delete the comma after "station" in last sentence.

FOF No. 46

This finding is modified to read as follows:

46. In the Omega system, as built and used by defendant, the three frequency format is *always* transmitted (except when one or more of the three frequencies is temporarily off the air for maintenance). There is never an intentional period of transmission of a format less than three frequency, and the three frequency format is described by defendant as a "frequency requirement for all Omega stations."

FOF No. 53

Delete ", quantity-produced" from the first sentence. In the third sentence, change "(XN-D)" to "(NX-1)."

FOF No. 54 through FOF No. 65

Eliminate entirely.

FOF No. 66

Insert "effective April 3, 1970" after "N00039-70-C-0533" and substitute for the last sentence of the first paragraph the following:

> However the ninth set was never connected to an Omega transmitter to generate signals and, thus, was never part of the claimed combination.

FOF No. 68

Insert "effective October 5, 1970" after "N00039-71-C0012" in the first sentence.

FOF No. 69

Insert "effective May 9, 1969" after "N00039-69-C-0560" in the first sentence.

FOF No. 72

Eliminate last sentence of first paragraph.

FOF No. 74

Change the first sentence to read as follows:

Plaintiff, through its American subsidiary, Decca Navigation Systems, Inc., by an agreement dated November 9, 1961, licensed Bendix Corporation to manufacture, have manufactured, sell and/or use transmitters and receivers for plaintiff's Decca Navigator Systems and Dectra Systems.

FOF No. 78

Eliminate entirely.

FOF No. 90

Substitute the word "inclusive" for "exclusive" in the last sentence of the last paragraph.

FOF No. 94

Change the last sentence to read as follows:

But for this fact, the stations would have been capable of operation in the three frequency mode.

FOF No. 96

Change this finding to read as follows:

96. The necessary station electronics for the Omega stations in Argentina, Liberia, and La Reunion, although in the possession of defendant prior to the expiration of the '816, were not operational by that date.

FOF No. 104

Insert the word "interim" after "The" and before "station" in the first sentence.

FOF No. 105

Insert the word "interim" after "the" and before "Norway" in the first sentence.

FOF No. 106

Insert the word "interim" after "The" and before "station" in the first sentence.

FOF No. 109

Substitute "(XN-1)" for "(XN)" in the last paragraph.

FOF No. 112

Substitute the number "95" for "165" in the first sentence.

FOF No. 113

In the next to last sentence, substitute "-99(V)4" for "-00(V)."

FOF No. 118

This finding is modified to read as follows:

> 118. Four BRN-7 receivers were ordered as first articles, with first article testing to be performed by the contractor, under line item 0001 at a target cost of $407,710 each, the total target cost for the testing of the four items being $1,630,840. A ceiling cost of $1,797,037 was established in the contract.[25] These four sets were delivered to the Government under line item 0001. The Government returned the four first article items to the contractor, who refurbished them and delivered the refurbished items to the Government under line item 20 at a price of approximately $53,000 per receiver. The four first articles were not tested in combination with signals transmitted by Omega stations.

FOF No. 122

Insert the words "post-installation" after "The" and before "differences" in the last sentence of the finding.

FOF No. 123

In the next to last sentence, change "EC-1300" to EC-130Q."

FOF No. 124

Delete last sentence.

FOF No. 125

Delete the last two sentences and add the following:

The mere procurement of uninstalled and unconnected components of ARN-99 and BRN-7 receiver sets is not manufacture or use by or for the Government of the patented invention.

FOF No. 127

Substitute "make, have made, sell and/or use" for "manufacture and sell" in the second sentence.

FOF No. 142

Change the finding to read as follows:

142. If and when Decca were to develop transmitters and receivers for the Omega system, ITT/NSI had a license not only to manufacture them, but it was also licensed to use them.

FOF No. 143

Change the finding to read as follows:

143. The royalty payable under an exclusive patent license, more often than not, is higher than that under a nonexclusive license. In this case, the "license" taken by defendant approximated an exclusive license under the '816 patent.

FOF No. 144

Substitute the word "exclude" for "include" in the first sentence.

FOF No. 149

Change the finding to read as follows:

149. There never has been an arm's length commercial sale of an entire Omega system from which a fair market sale price can be determined. The nearest system, by comparison, is Decca's MK X system. It is a Low Frequency (LF) system which has short range and smaller equipment but, otherwise, it is the same in principle as Omega, and is generically covered by the patent

in suit. The technical problems of erection are substantially the same. Decca sold such systems as "turn key" jobs. Decca's MK X system was in direct competition with the LORAN-C system for short-range usage.

FOF No. 150 through No. 152

Eliminate entirely.

FOF No. 154

Eliminate last sentence.

FOF No. 155

Change the first sentence to read as follows:

If compensation is to be based on cost of establishing the system, the "entire market value" rule, as delimited by the definition of "transmitter" in the Bendix license, is applicable for purposes of determining the quantum of liability.

Eliminate last sentence of the finding.

FOF No. 156

Change the finding to read as follows:

156. The 10.2 kHz frequency transmitted as one frequency of the Omega system is capable of noninfringing use. The Omega system, however, is utilized in initializing such single-frequency receivers.

FOF No. 157 and No. 158

Eliminate entirely.

FOF No. 159

Change the finding to read as follows:

159. Plaintiff's license to ITT/NSI provided a royalty rate of 5 percent for an exclusive license in its patents, including the '816 patent in suit. The United States, having announced and having proceeded to implement its intention to establish Omega, caused plaintiff to accept a reduction in the royalty rate from ITT/NSI as compared with that provided under the Bendix license. The 5 percent royalty rate, therefore, should not be considered a reasonable rate, but a forced minimum.

FOF No. 160

Change to read as follows:

160. Since the royalty rate for an exclusive license may be 50-100 percent higher than that for a nonexclusive license, a reasonable royalty under the ITT/NSI license, if truly exclusive, would have been at least 7.5 percent. No decrease in the royalty rate is warranted on account of defendant's in-house development, since the value of such contribution was taken into account in the prices paid for the components procured from defendant's suppliers.

FOF No. 161

Eliminate entirely.

FOF No. 162 through No. 165

Findings Nos. 162-165 are deleted and are replaced by the following finding:

Delay compensation is measured by simple interest running from the first day on which a royalty became payable. Delay damages should be computed at the rates set forth in *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106 (1976), *cert. denied*, 434 U.S. 1051 (1978). In light of the affirmative showing on the part of plaintiff of a higher delay compensation rate for years after 1975 than that stated for the quinquennium of 1971 to 1975 in *Pitcairn*, a rate of 8 percent will be applied for years after 1975, up to and including the date of payment of the judgment.

FOF No. 166

Eliminate entirely.

Conclusion of Law

Eliminate entirely.

Appendix A

Eliminate entirely.

By The Court
Philip Nichols, Jr.
Judge, Presiding

United States Court of Claims

No. 299-70
(Decided July 9, 1976)

DECCA LIMITED v. THE UNITED STATES

Robert B. Russell, attorney of record for plaintiff. *Henry C. Nields, and Russell & Nields*, of counsel.

Joseph A. Hill, with whom was *Assistant Attorney General Rex E. Lee*, for defendant. *Paul F. Arsenault*, of counsel. *Albert Sopp*, Naval Electronic Systems Command, Department of the Navy, of counsel.

Before NICHOLS, KASHIWA, and KUNZIG, *Judges*.

OPINION

PER CURIAM: This case comes before the court on defendant's exceptions to the recommended opinion, findings of fact and conclusion of law of former Trial Judge Cooper, submitted in accordance with Rule 134(h), in which he holds that the United States has infringed *within the United States*, claims 1, 4 and 11 of O'Brien, et al., United States Patent No. 2,844,815, and must pay reasonable and entire compensation under 28 U.S.C. Sec. 1498, the amount thereof being left to future proceedings under Rule 131(c). The alleged infringing device is the United States Government's worldwide Omega system for positioning ships and aircraft. The case has been submitted to the court on the briefs and arguments of counsel. Upon consideration thereof, since the court agrees with the said recommended decision, except for one sentence, it adopts the same as the basis for its decision in this case, except for that sentence, which we have deleted.

We agree in general with the trial judge's handling of the extraterritoriality problem, but have eliminated a sentence to avoid giving the impression that we rely on what we believe to be the not unchallengeable proposition, that the territorial re-

quirements of the United States Patent Laws are met simply because United States flag vessels or aircraft, receiving Omega signals while on or over the high seas, are ambulatory portions of United States territory. We think the territorial requirements of our laws are met otherwise in this case, so this juridical prop is not necessary.

The problem arises from the fact that, as held in *Deepsouth Packing Co.* v. *Laitram Corp.*, 406 U.S. 518 (1972), United States Patent Laws are territorial in their application and by their own terms are not infringed by acts in foreign countries, that would be infringements at home. That case excluded shipment abroad of components of shrimp deveiners, for assembly there, although they had been held, when asssembled at home, to infringe certain United States combination patents. The Court referred to provisions of the Patent Code, 35 U.S.C. Secs. 154 and 271, the former of which makes a United States Patent convey the right to exclude others from making, using, or selling the invention "throughout the United States" and the latter defines infringement as making, using, or selling the invention "within the United States". By Sec. 100(c) "United States" means "the United States of America, its territories and possessions". Patent claims, it was said, must moreover be construed strictly in light of "this Nation's historical antipathy to monopoly". 406 U.S. at 530.

It has several times been held that the fiction, as it has been called, that a United States flag vessel is United States territory, does not extend so far as to make general United States laws, enacted for territorial application, and without express reference to shipping, applicable to United States flag ships at sea. *United States ex rel,. Claussen* v. *Day*, 279 U.S. 398 (1929); *Cunard S.S. Co.* v. *Mellon*, 262 U.S. 100 (1923); *Scharrenberg* v. *Dollar S.S. Co.*, 245 U.S. 122 (1917).

The parties, addressing this problem on inquiries from the bench, seem to have supposed the answer was primarily found in *Brown* v. *Duchesne*, 60 U.S. (19 How.) 183 (1857). In that case a United States Patent was held not infringed by a device carried as

part of the equipment of a French flag vessel to a United States port, because, it was held, an implied exception to the United States Patent Laws existed for that particular situation. Congress could not by its general language have intended to empower patentees to harass and obstruct foreign flag ships in our ports, fitted out in conformity to the patent laws of their own countries, and trading to our ports pursuant to treaties guaranteeing them equal access. That case is quoted and followed in *Benz* v. *Compania Naviera Hidalgo, S.A.*, 353 U.S. 138, 146. (1957), holding that United States Labor Laws do not apply, to labor disputes on board foreign flag vessels during their temporary stays in United States ports.

In the situation of "flag of convenience" ships beneficially owned by United States nationals, but under foreign flags, the Supreme Court has had difficulty, whether and when to imply exceptions to United States Law of this kind. *Hellenic Lines Ltd.* v. *Rhoditis*, 398 U.S. 306 (1970); *McCulloch* v. *Sociedad Nacional*, 372 U.S. 10 (1963); *Lauritzen v. Larsen*, 345 U.S. 571 (1953). Sometimes it does so, sometimes not, as these cases illustrate.

In *Gardiner* v. *Howe*, 9 Fed. Cas. 1157 (1865), the court held that a United States Patent could be infringed by use on board a United States merchant vessel on the high seas. The court took the view that the United States Patent Laws extended to any place under United States jurisdiction. In *Marconi Wireless Tel. Co.* v. *United States*, 99 Ct. Cl. 1 (1942), *affirmed in part, vacated in part*, 320 U.S. 1 (1943), order on remand, 100 Ct. Cl. 566 (1943), this court followed *Gardiner* v. *Howe*, which it deemed, with *Brown* v. *Duchesne*, the only available authority, to hold that the Marconi patents were infringed by a group of receivers made and used at the United States Naval Radio Station at the American Legation in Peking, China. Though not mentioned in the opinion, it is of course well known that the United States then enjoyed extraterritorial rights at that location. The applicability of these cases today, to the instant problem, may be deemed questionable, both from their apparent inconsistency with *Cunard S.S. Co.* v.

Mellon and *Deepsouth Packing Co.* v. *Laitram Corp.*, both *supra*, and still more, because the definition of "United States" in 35 U.S.C. Sec. 100(c) was only added to the Patent Code by the 1952 revision. *See*, 2 U.S. Code Cong. & Adm. News (1952) 2394, at 2409. Before then the Patent Laws did not define their own scope in a manner that so plainly confined them to states, territories and possessions. We do not, however, disapprove or overrule *Gardiner* v. *Howe* and *Marconi Wireless*. We only rely on them lightly and with hesitation.

It might be thought—and was in the *Marconi* case—that an implied exemption of foreign flag shipping from United States Laws, even when in United States ports, might as a logical corollary demand a corresponding extension of the same laws to United States ships, even though at sea or in foreign waters. However, an exception to a statute is always easier to imply than an extension is. Any such proposed extension would have to be considered on the merits of the case. Of course, when Congress expressly and consciously legislates for shipping or aircraft, the problem vanishes: it is solely one of construing general statutes. In the case of the Patent Laws the canon of hostile interpretation mentioned in the *Deepsouth* case provides an added obstacle to implying an extension of the United States Patent Laws to correspond to the exception implied in *Brown* v. *Duchesne*.

In view of the foregoing, we think a decision founded on the fiction that for purposes of the Patent Laws, United States ships and planes wherever found, are United States territory, would be founded on water. We think, however, that the question can be left open, and still we find enough other basis for concluding that the location of the infringement is within United States territory, not abroad as in *Deepsouth*.

The alleged infringing system, Omega, is fully described in the trial judge's opinion and findings. It is a worldwide United States Government system for broadcasting radio waves of a particular kind to be received on ships or aircraft by receivers able to receive and use them, to pinpoint the location of ships and planes on or

over the sea. Loran does the same job, but Omega is expected to succeed it. The broadcasting equipment is designed and built by the United States Government. There are two stations in the United States, and at present one in Norway, but others in foreign locations are projected. Two stations are necessary for a line of position and three for an exact fix, by the meeting of two lines. The receivers in the ships or planes read the signals into computers and read out exact information as to location. The United States Government does not necessarily provide the receivers, and they can be of a variety of designs. The system would be worth little if it did not operate worldwide, at least as an ultimate goal, so that, a receiver once installed, the ship or plane can use it to navigate anywhere. Of its very nature the system cannot be confined to one country, but we do not think it is without any territoriality merely because it operates in more than one country, and at sea. Its home territory is, we think, where the broadcast stations are, but if they are in more than one country, the location of the whole for purposes of the United States Patent Law is where the "master" station or stations are, which is in the United States of America, and where all the stations are monitored, presently Washington, D.C. All stations broadcasting in the system have to be brought into exact synchronization with the United States stations. The receivers have to be programmed to receive and measure the time differences in arrival of signals and interpret the differences. Thus they are in a manner "slaves" just as the foreign stations are. We do not think that the necessarily scattered and changing position of receivers, with those actually functioning for the most part at sea, in or over the territory of no sovereign, have any necessary connection with the location of the Omega system for purposes of the United States Patent Laws. It is located in the United States. This analysis agrees with that of the Patent Office Board of Patent Interferences. *Rosen* v. *NASA*, 152 USPQ 757 (1966), holding that an invention concerning space satellites was reduced to practice in the United States because of the location of control stations here.

This view does not claim an extraterritorial effect for United States Patent Laws, as did the view rejected in *Deepsouth*, *supra*. Neither, is there a probable conflict with the patent laws of other countries. It could perfectly well have been that the assembly of the shrimp deveiners, *e.g.*, in Brazil, could have been of concern to the patent laws of Brazil, which might have provided different consequences for the assembly than the United States laws would have. Here, if a foreign country, host to a "slave" broadcast station, attempted to apply its patent laws to that station in a harassing way, we suppose it would be viewed like the attempted application of United States Law to the French ship in *Brown* v. *Duchesne*. It would be an anomaly, though not impermissible. The French were not given extraterritoriality there. Any foreign country that consents to the entry of any element of the Omega system into its territory impliedly consents also, it would seem, to abstain from any application of its own patent law that would interfere with the intended use. If it breached this implied understanding, the remedy would be not to claim extraterritoriality, but, to remove the station.

At any rate, the whole Omega system must be deemed, at least for purposes of litigating the patent here involved, to be a unity, and the location of that unity must be deemed to be in United States territory. Here it has planted several of its feet, and use of United States Territory is indispensable to it. The location of facilities in some foreign countries is also essential to the plan, but, the selection of any single other country is, apparently, not essential. Any one such country could readily be abandoned for another.

Therefore, it is concluded that the above stated patent claims have been infringed. The plaintiff is entitled to recover and judgment is entered to that effect.

The opinion, as modified, findings of fact, and conclusion of law of the trial judge follow.

OPINION

COOPER, *Trial Judge:* Alleging that the world-wide Omega navigation system sponsored by the United States is an infringement of claims 1, 4 and 11 of its O'Brien et al. Patent No. 2,844,816, plaintiff brings this action for reasonable compensation under 28 U.S.C. § 1498. Defendant resists the claim, contending that the patent is invalid because the disclosed embodiment is inoperative and because the disclosure does not meet the requirements of 35 U.S.C. § 112.[1] In addition, defendant maintains that the Omega system is not covered by any of the claims here in issue. Finally, to the extent that the case for infringement is based on equipment located in foreign countries, defendant maintains that the patent laws of the United States and, hence, 28 U.S.C. § 1498, extend only to the territorial limits of the United States and preclude recovery based on equipment in such countries.

For the reasons stated hereinafter, it is concluded that plaintiff has carried its burden of proving infringement of claims 1, 4 and 11. It is further concluded that defendant has not established invalidity of the patent on the grounds asserted, and that the extraterritorial issue raised by defendant does not preclude a finding of liability in this case.

I

The technology here in issue relates to hyperbolic radio navigation systems wherein separate transmitting stations fixed at known locations send out radio signals, that are sensed by a mobile receiver at a position remote from the transmitters. In hyperbolic navigation, the receiver measures the time difference in arrival of the radio signals, the time difference, being a measure of the difference between the distances traveled by the signals. In this way, a line of position (LOP) on which the receiver is located can be identified. The system is referred to as hyperbolic because the lines of position, as shown on a navigation chart, are in the form of hyperbolas. These hyperbolic LOPs are described as the path

[1] Defendant makes no contention that the claims are invalid under either 35 U.S.C. § 102, § 103 or having expressly waived those defenses.

traced by a point moved in such a way that the distances between it and each of a given pair of transmitters always differ by a constant.

In hyperbolic navigation, signals from at least three stations are necessary, the signals from one pair of the stations being used to identify one LOP and the signals from another pair of the stations identifying another LOP. The intersection of the two LOPs provides a position fix which pinpoints the receiver's location.

On hyperbolic navigation charts, adjacent hyperbolic lines define between them a zone or lane. If the radio signals from two stations are received exactly in phase with each other, this indicates that the receiver is on one of the hyperbolic lines. If however, the signals are out of phase, this indicates that the receiver is in between the hyperbolic lines, *i.e.*, in one of the lanes. The problem with which both the '816 patent and the Omega navigation system are concerned is one of ascertaining which of the lanes the receiver is in and where it is in that lane.

In the '816 patent, the width of the larger zones or lanes was chosen to correspond to 1f, *i.e.*, one hyperbolic line of position is separated from the next adjacent line by one-half cycle of the fundamental frequency. If, as is the case with the accused Omega system, the 1f frequency is 1.133 khz., the basic lane width, as measured on the base line between two stations, is 72 nautical miles.[2] Since hyperbolic navigation charts are conventionally based on 9f, at that frequency, the lane width is 8 nautical miles. Hence, the problem of lane identification is one of determining which 8-mile-wide lane the vehicle carrying the receiver is in and, also, where it is in that 8-mile-wide lane.

The '816 patent, and in particular, the embodiment of Figures 4, 5 and 7 thereof, proceeds on the assumption that the navigator knows where he is within ± 36 miles, that is, that he knows which group of nine 8-mile-wide lanes he is in but not where he is in that group. To resolve that problem, the '816 patent proposes to use signals of 9f, 10f and 12f sent from each of two transmitting stations A and B, the signals from each of the stations being transmit-

[2] Lane width may be expressed in various ways. Stating it in nautical miles always requires specifying the frequency and an understanding that the measurement is "on the base line." As used herein, reference to nautical miles (n.m.) is to be understood to refer to a measurement on the base line.

ted in phase with each other. The transmission pattern of the signals is distinctively altered periodically so that the receiver can tell which of the stations it is receiving at any given time. At the receiver, the phase values of the 9f signals from stations A and B are stored and compared. The difference in phase of these two signals is proportional to the difference in time of propagation, and is indicative of the position of the receiver in a 9f lane. In other words, by phase comparing the two 9f signals, the receiver provides a readout, referred to in the patent as the "fine" control, which tells the navigator where he is in a lane 8 miles wide.

It will be appreciated that this still leaves the question of which 8-mile lane the receiver is in. To resolve that problem, the receiver of Figure 7 uses ÷ 3 dividers and mixers to develop a 1f signal from each of the two stations. This is accomplished, as to each station, by "beating" or subtracting the 9f and 12f signals to obtain a difference frequency or 3f beat signal, which notches a divider to produce from the original 9f signal a 3f output in phase with that original signal. Then, by beating the 9f and 10f signals to obtain a 1f difference signal, a second set of ÷ 3 dividers is notched to produce from the 3f signal a 1f signal which carries the same phase as the original 9f. This is performed in two separate channels of the receiver, one channel processing the signals from station A and another channel processing the signals from station B. The two 1f signals thus produced from stations A and B are then phase compared and the phase difference is reflected in what the patent terms a "coarse" control. The coarse control indicates the position of the receiver in a 1f lane, *i.e.* a lane 72 miles wide or, stated otherwise a group of nine 8-mile-wide lanes.

Taking the two readouts together, the navigator is provided with a LOP which tells him which lane out of a group of nine lanes he is in and where he is in that particular lane. To establish a position fix, the '816 patent proposes a third station C which will provide a third set of 9f, 10f and 12f signals, and these signals are processed in a third channel of the receiver. Thus, the signals from stations A and B, when processed as described, will provide one LOP

and the signals from stations A and C will establish a second LOP. Where the two LOPs cross, the position of the receiver is established.

At this point, and before discussing the Omega system, it is well to consider defendant's contentions concerning the invalidity of the patent. Defendant contends that the read-outs from the '816 receiver are meaningless because they could refer to any one of an infinite number of hyberbolic isophase lanes. Further, it is contended that the action of the mixers and dividers destroys the phase integrity of the signals in the receiver and, lastly, that the transmitters disclosed in the patent are incapable of producing a stable pattern.

Defendant's evidence in support of these defenses is not persuasive and none of these contentions can be sustained. There is no doubt that the '816 receiver is limited in its lane resolution capability to an unknown of ± 36 miles. But so is the Omega system yet to be described. The important point is that the '816 patent does disclose a system which, within its defined limits, is operative to resolve lane ambiguity. The mere fact that the system has some drawbacks, or that under certain postulated conditions it may not work, or that better, more sophisticated, equipment has been developed which does a better job does not detract from the operability of the disclosed equipment to perform its described function.

Nor does the fact that in the "real world" radio waves are subjected to a variety of disturbances and aberrations alter this conclusion. As described in finding 8, the '816 receiver does provide some compensation for these aberrations and it is in response to this very problem that the patentees suggested using the three frequencies 9f, 10f and 12f. With these three frequencies, the patentees found they could cope with about three times the perturbation as with only two frequencies.

Quite clearly, inoperativeness is not established merely by showing that the particular disclosed embodiment for carrying out the principles of the invention is lacking in perfection. *Field* v.

Knowles, 183 F.2d 593 (CCPA 1950). In this respect, it is worthy of note that a "raw" LOP, that is, one in which there has been no correction for the aberrations and unwanted effects encountered by the radio waves, still has utility for rendezvous purposes and it is precisely for this purpose that the accused Omega system was designed to have the capability of producing similar readouts.

Nor is there merit in defendant's contentions respecting inadequacy of the disclosure. Based on the record in this case, there is no doubt that one of ordinary skill in the art would be able to understand the patent disclosure and, from that disclosure, using the skill of the art, could build an operative system. That is enough to satisfy the requirements of 35 U.S.C. § 112. *Bowser, Inc.* v. *United States*, 181 Ct. CI. 834, 388 F.2d 346 (1967); *Trio Process Corp.* v. *L. Goldstein's Sons*, 461 F.2d 66, 74 (3d Cir. 1972), *cert. denied*, 409 U.S. 997.

Accordingly, it is concluded that claims 1, 4 and 11 are valid.

II

Considering now the accused Omega system, it is a very low frequency (VLF) radio navigation system in which eight transmitters are to be located at strategic locations around the world. At the present time, only three stations have been completed, two in the United States (Haiku, Hawaii, and La Moure, North Dakota) and one in Norway. When the system is completed, signals from these eight stations will provide all-weather navigational service throughout the world.

The hyperbolic radio navigation technique is basic to the Omega system; however, the system is designed to have capabilities beyond that. For example, a navigator equipped with a suitable receiver can also employ rho-rho (or range-range) navigation. This latter type of navigation employs a circular grid, instead of hyperbolic, and requires signals from only one station. Nonetheless, it is clear that both of the receivers accused to infringe, the AN/ARN-99 for surface and aircraft, and the AN/BRN-7 for submarines, use the hyperbolic mode for

establishing an initial position. The ARN-99 can then go to a rho-rho mode but the BRN-7 remains at all times in the hyperbolic mode. In addition, both receivers have the capability to display, at any time, a "raw" hyperbolic LOP. Since the '816 patent is concerned only with hyperbolic navigation, the accused system will only be considered from that standpoint, it being recognized that the rho-rho capability is an additional feature of the ARN-99.

The Omega system is designed to use the latest, most modern and sophisticated equipment. At the Omega transmitters, atomic clocks in the form of cesium beam standards are used to coordinate the transmissions from each station and to ensure that all stations are in synchronism with each other. Each station transmits signals of 9f, 10f and 12f in a distinctively altered pattern so that the receiver is able to determine which station it is receiving and to synchronize itself with the incoming radio waves.

Each receiver consists of a three-channel radio receiving section and a computer section. The computer is a militarized general purpose digital computer that has been preprogrammed for Omega navigation. The navigator cannot change the program in the computer or, in any way, alter the routine of the computer. The radio receiver section consists of amplifiers, mixers and other component hardware by which the incoming 9f, 10f and 12f signals may be processed and converted to digital information which the computer can handle. This is done in each channel of the receiver by beating each of the incoming 9f, 10f and 12f signals against the output of a local oscillator to produce three separate intermediate frequencies (If), each of which carries the phase information of the respective 9f, 10f and 12f signals. This phase information is then converted into a series of electrical pulses representing binary digits that are fed into the computer section and stored in the memory core.

As with the '816 patent, the Omega receiver is able to determine its initial position only within ± 36 miles when it operates in the hyperbolic mode. In other words, the navigator must know which 72-mile-wide lane he is in and the receiver will then be able to

determine, by a laning procedure, which of nine 8-mile-wide lanes it is in and where it is in that particular 8-mile-wide lane. That is achieved in the following manner, it being recognized that the described functions are actually performed by the computer through a process of "state vector" analysis to arrive at a determination of which 8-mile-wide lane the receiver is in. The 9f, 10f and 12f frequencies are "differenced," that is, the 9f and 10f signals from each of two stations are subtracted to develop a difference frequency of 9f, the 9f and 12f signals are subtracted to arrive at a 3f and the 10f and 12f signals are subtracted to arrive at a 2f. With a fundamental frequency of 1.133 khz., the basic frequencies of 9f, 10f and 12f define lanes 8, 7.2 and 6 miles wide, respectively, while the difference frequencies of 1f, 2f and 3f define hyperbolic lanes of 72 miles, 36 miles and 24 miles, respectively. The computer uses its stored phase information to make a phase comparison of the signals from the two stations at these difference frequencies to establish a position in the larger lanes. By using three frequencies, ambiguities in the position in the lane are resolved. The speed of the digital computer is such that it can difference the frequencies and make the phase comparisons a number of times in a matter of seconds. It then averages the results of its computations and arrives at a best estimate or determination of which 8-mile-wide lane it is in.

Having made that determination, the computer then switches from the difference frequency mode to the single frequency mode. In this mode, it compares the phase of a single frequency from each of two stations. For example, it will make a phase comparison of the 9f signals from stations A and B and since that frequency defines an 8-mile-wide lane, the phase difference is indicative of where the receiver is in the 8-mile-wide lane previously identified. Here again, the speed of the computer is such that it can perform the operation a number of times and average the results within seconds before producing a readout.

Once the receiver has established its position, it can then simply count the hyperbolic lanes as it crosses each one. If, at any time, the operator wants to know his position, the receiver will, on command, display a raw hyperbolic LOP. That LOP consists of the current lane count, *i.e.*, the number of the 8-mile-wide lane which the receiver is in, and, by a phase comparison of the 9f signals as described above, a digital display of how far across that lane the receiver has progressed as of that moment. The accused receivers have the further capability to apply various programmed corrections to their calculations and to convert position determinations to a readout expressed in latitude and longitude.

III

Turning to the issue of infringement, claim 1 is as follows:

> A hyperbolic radio navigation system in which a position line is determined by indicating the difference in the time of propagation to a receiver of signals emitted from two stations in known spaced geographical positions, wherein three signals are emitted from a first station satisfying the respective phase conditions, given in radians of angle, $n_1 w_0 t + \alpha_1$, $n_2 w_0 t + \alpha_2$ and $(n_1 + 1) w_0 t + \alpha_3$, and three signals are emitted from the second station satisfying the respective phase conditions $n_1 w_0 t + \alpha_1 + k$, $n_2 w_0 t + \alpha_2 + k$ and $(n_1 + 1) w_0 t + \alpha_3 + k$, where n_1 and n_2 are integers, w_0 is 2π multiplied by a fundamental frequency in cycles per second, t is time in seconds and α_1, α_2, α_3, and k are constants, the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other station, and the transmission being distinctively altered periodically for synchronizing switching means at the receiver with the switching of the transmissions and wherein the receiver comprises means for receiving the radiated signals, switching means which are synchronised by the distinctive alteration in transmission and which are arranged to separate the received

signals from the two transmitters, and a phase difference indicator for indicating the difficulties in time of propagation which indicator has a recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental frequency, said indicator being operated by a fine control and a coarse control, said fine control being dependent on a pair of signals derived from locally generated non-interrupted signals, one of which is phase-controlled by only one of the signals received from said first station and the other by only one of the signals received from said second station and the coarse control being dependent on six received signals derived from the three different frequencies transmitted from each of the stations.

Defendant correctly urges that more than a literal response to the terms of this claim must be shown for plaintiff to make out a case of infringement. *Westinghouse* v. *Boyden Power Brake Co.*, 170 U.S. 537, 568 (1898). Not only must that be demonstrated, but it must also be shown that the accused system does substantially the same work in substantially the same way to accomplish substantially the same result as the claimed system. *Marvin Glass & Associates* v. *Sears, Roebuck & Co.*, 448 F.2d 60 (5th Cir. 1971); *Dominion Magnesium Ltd.* v. *United States*, 162 Ct. Cl. 240, 320 F. 2d 388 (1963).

With respect to the literal readability of claim 1 on the Omega system, this is set out in finding 19 and no useful purpose is served in repeating it here. Suffice to say that plaintiff has sustained its burden of showing, by a preponderance of the evidence, that the Omega system, with two transmitters such as those at Haiku and La Moure and with either the ARN-99 or the BRN-7 receivers, does respond to the literal language of claim 1.

Notwithstanding literal readability, defendant maintains that the Omega system does not employ substantially the same means to provide the same end result. In particular, defendant relies on the fact that a general purpose digital computer is used in Omega as compared to the analog arrangement disclosed in the patent;

that the computer is of a type used for many other purposes; that it is the computer software that actually performs the calculations from which lane identification is made and that this software is nothing more than a set of equations; and that the Omega receivers are capable of doing far more than the receiver disclosed in Figure 7 of the '816 patent.

Of course, the mere fact that one or more elements of an accused combination, in this case the computer, are susceptible of noninfringing uses does not mean that all systems employing those same elements avoid infringement. *LaSalle Street Press* v. *McCormick & Henderson, Inc.*, 445 F.2d 84, 94 (7th Cir. 1971). Hence, the testimony that the same general purpose computers are used in noninfringing systems employed on bombing missions is utterly irrelevant to the question of whether the computer, when combined with the other elements of the Omega system, infringes the navigational system of claim 1.

With respect to the contention that defendant's use of digital means distinguishes the accused system, it is to be noted that the claim is not, by its terms, in any way limited to the specific analog mechanism disclosed. Also, the specification contains no indication that it was the configuration or details of the particular apparatus disclosed that was considered by the patentees to be their invention. Indeed, as it is stated at col. 7, lines 4-6 of the patent, "there are many ways of constructing a receiver to give identical or equivalent information" to that achieved with the receiver shown in Figure 7. Nor is there either prior art which requires that the claims be limited to the apparatus disclosed in order to preserve its validity, or proof that the doctrine of file wrapper estoppel requires such a limited construction of the claim. In short, the evidence supports the conclusion that it was a system which included a receiver capable of performing the functions of sychronizing itself with the transmitted signals, separating the signals, and producing from those signals a fine and coarse readout that was the invention, not the specific mechanism by which the receiver achieved those results. On these facts, infringement is not

avoided by showing that digital instead of analog techniques are used in the accused system. *National Dairy Products Corp.* v. *Swiss Colony, Inc.*, 364 F. Supp. 134, 152 (W.D. Wis. 1972).

Nor are defendant's arguments regarding the software any more persuasive. While *Gottschalk* v. *Benson*, 409 U.S. 63 (1972) held that computer programs were not patentable per se, claim 1 is clearly directed to a combination of elements and not just to a program. Nor does claim 1, as applied to Omega, read only on the program in the computer. Indeed, as defendant's expert testified at trial, the program accomplishes nothing by itself; it must be mechanized to achieve the navigational functions for which the Omega system is designed. Thus, defendant's argument that the burst filter, the tracking filter and the Kalman filter by which the Omega computer processes the data are "mere abstractions" having no "physical" existence is entirely beside the point. The theory on which, for example, the Kalman filter is based, and the instructions or program for the computer itself, may be nothing more than a set of equations, but the means for receiving the signals and processing them and the means for performing those instructions and achieving the end result quite clearly have a tangible, physical existence which meets the terms of the claim.

Nor can any weight be given to defendant's arguments regarding the sophistication of Omega as compared to the '816 embodiment. As defendant points out, digital computers were not really available in 1954 and the Kalman filtering process was not even developed until 1960. And there is no doubt that the Omega system, with atomic clocks and computerized operation, is able to provide for more accurate readouts of position than would have been achieved with the embodiment of Figure 7 in the patent. However, merely because the accused system is an improvement over the patented system does not mean that it does not also infringe the patent. *Eastern Rotorcraft Corp.* v. *United States*, 184 Ct. Cl. 709, 397 F.2d 978 (1968).

What is controlling here is that the Omega system, when operating in the hyperbolic mode, uses the basic system that was

the contribution of the patentees in the '816 patent. Thus, 9f, 10f and 12f signals are radiated in phase in a distinctively altered pattern and sequentially switched from two spaced transmitters; the distinctive pattern of the transmissions is used to synchronize the receiver with the sequence of the transmission; the signals are received and they are separated into separate processing channels; an indicator in the form of an LOP readout is provided, with the readout displaying a "coarse" position and a "fine" position; the fine position is dependent on the received and stored 9f signals and a phase comparison of those two signals; and the coarse position is obtained by frequency differencing the 9f, 10f and 12f from each of the two stations and a phase comparison of those signals. That is the system defined by claim 1, that is the patentees' contributions defined by that claim and that is how Omega works. Having shown that by a preponderance of the evidence, plaintiff has met its burden. *Stamicarbon, N.V.* v. *Escambia Chem. Corp.*, 430 F.2d 920 (5th Cir. 1970), *cert. denied*, 400 U.S. 944.

Claim 4 is dependent on claim 1 and merely adds the requirement that the signals be radiated in sequence. Omega clearly does so, and for the same purpose, as in the '816 patent.

Claim 11, the only remaining claim asserted here, adds the limitation of a third transmitting station radiating signals satisfying certain specified phase conditions vis-a-vis the signals from the other two stations. The outputs from these three stations, taken in pairs, permit development of two intersecting lines of position and, therefore, a position fix for the receiver. For the same reasons as were discussed in connection with claim 1, it is concluded that the accused Omega system has a third station radiating signals as described and that the receiver can and does operate in the manner claimed.

Defendant, however, points out that the only station other than those located at Haiku, Hawaii, and La Moure, North Dakota, is in Norway and, hence, outside the territorial limits of the United States. Citing *Deepsouth Packing Co.* v. *Laitram Corp.*, 406 U.S. 518 (1972), defendant asserts that a claim is infringed only when

an operative assembly of the entire claimed combination is made or used within the territorial limits of the United States. Defendant would have the court hold that since the third station required by the combination is in Norway plaintiff cannot show that the combination, as an operable assembly, was either made or used entirely within the territorial limits of the United States and that, therefore, there can be no liability under claim 11.

However, plaintiff is correct that *Deepsouth* really is not in point since that case dealt with a situation where the operative assembly of the claimed combination was completed and used wholly outside the United States. Here, only a portion of the claimed combination, one transmitter out of the requisite three, is located outside the United States while the beneficial use of the completed asembly actually occurs within the jurisdiction of the United States, when either a vessel or an airplane equipped with an Omega receiver and owned by the defendant receives and utilizes the signals in the manner claimed. Also, in *Deepsouth*, by the time the combination was assembled, all the elements of the combination had been sold and were in the hands of someone other than the domestic manufacturer. Here, all of the equipment in Norway was purchased by the United States, installed by the United States, continues to be owned by the United States, was operated initially by the United States and it operates today for the benefit of the United States under the direction and control of the United States. On these facts, *Deepsouth* cannot be considered to be controlling here.

The question thus presented is whether the system of claim 11 has been made or used, as those terms are employed in the patent law, by, or for the United States. Stated more factually, the issue is whether, despite the third station being located on sovereign Norway soil, the United States can be said to have either made or used the claimed system in the United States.

Neither party has cited any cases dealing with the precise question presented and it appears to be one of first impression. Plaintiff suggests that some guidance can be derived from tort principles

since patent infringement is a technical tort. In particular, plaintiff contends that, on the issue of which law to apply, the traditional rule is that a tort occurs when it is completed, where the last act occurs, even if part of the action leading up to it takes place elsewhere, or where the injury is sustained. Under that analysis, plaintiff urges that the tort of infringement was completed, and the injury sustained, when the receiver in the United States received the signals from all three transmitters. Accordingly, plaintiff urges that the infringement occurs in the United States. However, as defendant points out, it is settled that Governmental use of a patented invention is viewed as an eminent domain taking of a license under the patent and not as a tort, *Crozier* v. *Krupp*, 224 U.S. 290, 308 (1912), so the tort analogy is imperfect at best. Yet an analytical approach based on an eminent domain theory produces results similar to plaintiff's tort analysis. From the standpoint of a "use" by the United States, a cause of action under § 1498 arises when the accused equipment is first available for use, *Regent Jack Mfg. Co.* v. *United States*, 167 Ct. Cl. 815 (1964), and it is when the use occurs that a license is considered to have been taken. *Irving Air Chute Co.* v. *United States*, 117 Ct. Cl. 799 (1950). It is this taking of a license, without compensation, that is, under an eminent domain theory, the basis for a suit under § 1498. Here, it is when the receiver receives the signals in the United States that there is a completed use of the system. From a tort viewpoint, that is when the "injury" is sustained and from an eminent domain analysis that is when the license is taken.

Neither analytical approach, however, leads inexorably to a conclusion that claim 11 has been infringed. The plain fact is that one of the claimed elements is outside of the United States so that the combination, as an operable assembly, simply is not to be found solely within the territorial limits of this country. But there is no doubt that, to the extent possible, the system was made in the United States. By its very nature, the system has to have transmitters located outside of the territorial boundaries of this country, and it is necesary in installing those foreign transmitters to con-

struct certain aspects, *e.g.*, the radiating antenna and the helix coil, on site. It is also worth noting that the final steps to achieving an operable assembly of the system as a whole took place in the United States. Thus, before the Norwegian station could transmit, it had to be synchronized with the United States stations. This was accomplished by flying an atomic clock from North Dakota to Norway and, by using the epoch pulse of the clock, the Norwegian station was placed in phase with the United States stations. Then the atomic clock was flown back to the United States to be checked for any impermissible drift. It was only at this point that the three transmitters could be said to be an operable assembly radiating signals in the required phase relationship. Finally, the last element and the final link in a complete and operative system, a receiver having a phase difference indicator actually receiving and processing signals in the manner claimed, is in the United States.

Analyzed from the standpoint of a use instead of a making by the United States, a somewhat clearer picture emerges. The transmission from the Norwegian station is controlled by the United States in the sense that it established and continuously monitored the signals from that station, and this all occurs in the United States. In addition, defendant established through the use of atomic clocks, as previously described, the necessary synchronization of that station and part of that activity occurred in this country. Further, it is from the United States all actions are taken to ensure synchronization of the transmissions of that station with those in the United States. In other words, it is obvious that, although the Norwegian station is located on Norwegian soil, a navigator employing signals from that station is, in fact, "using" that station and such use occurs wherever the signals are received and used in the manner claimed.

In view of the foregoing, and while the matter is not free from doubt, it is concluded that a basis for liability under claim 11 has been shown. This conclusion does not rest on any one factor but on the combination of circumstances here present, with particular emphasis on the ownership of the equipment by the United States,

the control of the equipment from the United States and on the actual beneficial use of the system within the United States. In addition, one other consideration that should be mentioned is that it is clear from both the specification of the patent and the claim that the patentees' contribution was not in the manner by which a transmitter generated and radiated the signals, but rather it was in a system in which signals having a particular relationship were received from spaced sources and utilized in the receiver to arrive at a position fix. Had it been otherwise, that is, had the invention dealt with the generation of the signals themselves, it seems clear that utilization of those signals in this country would only have been incidental and that operation of the Norweigian station would have been beyond the reach of the U.S. patent laws. As it is, the result reached is believed to be consistent with the patentees' true contribution and serves to secure to them their just reward for that contribution.

Finally, in treating the extraterritorial issue, the parties have included all of the transmitting stations in their arguments. However, the one in Norway is the only one that need be considered to resolve the question of liability under claim 11. What the situation may be, either with respect to the other stations or the equipment purchased by the defendant but not yet installed, is a matter properly to be considered in the accounting, should it be relevant.

In conclusion, claims 1, 4 and 11 are valid and infringed and plaintiff is entitled to recover reasonable and entire compensation.

Findings of Fact

1. Patent No. 2,844,816, entitled "Radio Navigation Systems" issued July 22, 1958, on an application Serial No. 492,592 filed on March 7, 1955, by William J. O'Brien and Harold G. Hawker. Priority is claimed on the basis of an application filed in Great Britain on March 8, 1954. Ownership of the patent rests in plaintiff, a corporate subject of England, domiciled in London, England. Claims 1, 4 and 11 are the only claims in issue.

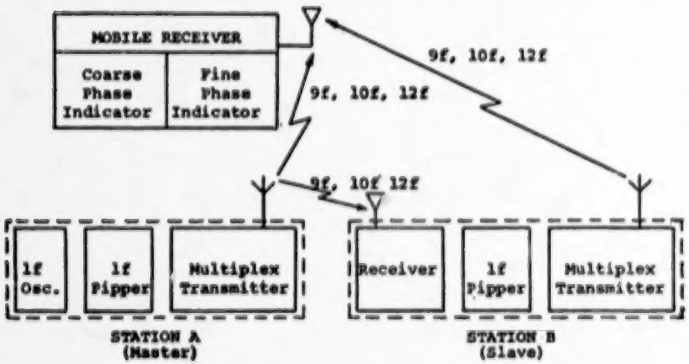
2. The patent in suit, herein referred to as the '816, relates to a system of radio navigation in which a plurality of transmitters transmit(s) a sequence of segments of continuous-wave (CW) radio signals, employing three specific, harmonically related frequencies, to be received on the "vehicle to be navigated," adapted to receive the signals separately and process them so as to determine the vehicle's navigational position by making a phase comparison of signals. The invention is particularly concerned with hyperbolic radio navigation systems in which separate transmitting stations fixed at known locations send out radio signals which are sensed by a mobile receiver at a position remote from the transmitters. The mobile receiver measures the time difference in arrival of the radio signals, the time difference being a measure of the difference between the distances traveled by the signals. In this way, a line of position (LOP) on which the receiver is located is identified. The system is referred to as hyperbolic because the lines of position are in the form of hyperbolas. Such a hyperbolic LOP would be the path traced by a point which moved in such a way that the distances between it and each of a given pair of transmitters always differ by a constant. By establishing a second line of position based on signals from a second pair of stations, the intersection of the two provides a position fix which pinpoints the receiver's location.

3. (a) The particular problem to which the '816 patent is directed is what is known as "lane resolution" or "lane identification." In a hyperbolic system, adjacent hyperbolic lines define between them a zone or lane. Lane identification is concerned with the problem of finding which lane or zone the receiver is in out of a group of lanes. In the '816 patent, the width of the larger zone or lane was chosen to correspond to 1f, i.e., one hyperbolic line of position is separated from the next adjacent line by one-half cycle of the fundamental frequency. This zone width can be expressed in various ways. Stating it in nautical miles always requires specifying the frequency and an understanding that the measurement is "on the base line" because hyperbolic lanes widen as they separate

from the base line drawn between two radiating stations. A more accurate and generic way to define it is to employ units which depend on phase difference because such a definition is accurate regardless of where the receiver is relative to the base line. Since the difference in phase of the two signals is actually proportional to the difference in time of propagation, albeit in different units, the 1f lane can be expressed as a time difference indication rather than a phase difference.

(b) If, as is the case with the accused Omega system, the 1f frequency is 1.133 khz., the basic lane width, as measured on the base line, is 72 nautical miles. At a frequency of 9f, the lane width is 8 nautical miles. Hyperbolic navigation charts are conventionally based on 9f so the problem of lane identification is one of not only determining which 8-mile lane the vehicle is in but also where it is in that 8-mile lane.

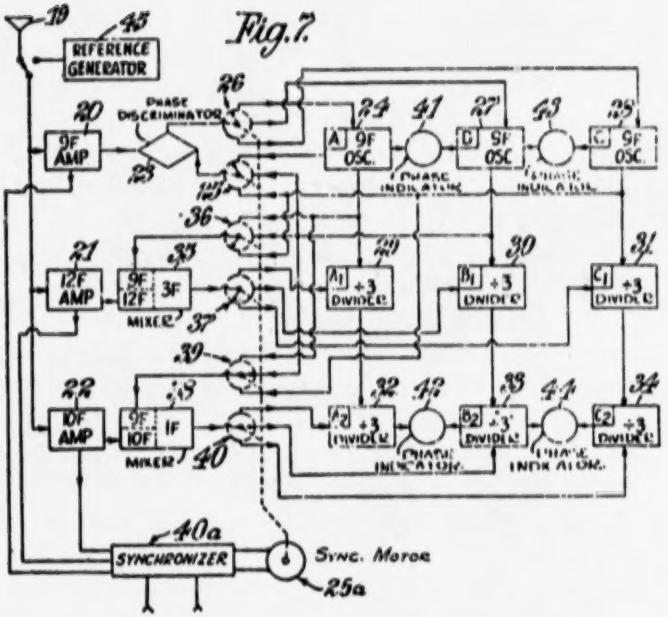
4. (a) The basic system contemplated by the patent is, in block diagram form, as follows:



(b) The patented system contemplates at least two stations, A and B. The transmitters of both stations are identical except that, to ensure synchronized radiation of their signals, the operation of station B is controlled, in a master/slave relationship, by station A. The transmitter produces output signals of 9f, 12f and 10f, by generating higher integral harmonics of a low basic fundamental frequency. A conventional audio oscillator constructed to generate a sinewave output signal of the fundamental frequency 1f, is connected to drive or actuate a 1f "Pipper." The pipper generates a repetitive wave train comprised of a series of very short, narrow pulses. These pulses, which are very rich in harmonic content, contain essentially all of the odd and even harmonics of the 1f input signal. The transmitter also includes three very sharply tuned amplifiers, and these are used to extract the 12f, 10f and 9f harmonics, respectively, from the spectrum of frequencies which appears at the output of the 1f pipper. The output of the power amplifiers is commutated out onto the antenna by means of a rotary switch provided with a rotor element which is driven by a synchronous motor. The rotary switch includes a set of conductive arcuate segments, each of which is sequentially engaged by the spinning rotor of the switch. As the rotor successively engages the arcuate conductive segments tied to respective power amplifiers, the harmonic signal thus received is applied to the antenna. The phase of the outgoing 12f, 10f and 9f harmonic signals is compared to the corresponding outputs from the 1f pipper, by means of a phase discriminator which compensates for any phase shifts that occur between the 1f pipper and the antenna.

(c) While two stations are shown in the block diagram, a third station would be required to obtain a position fix. This third station would also be in a master/slave relationship with station A and would function in the same manner as the other stations to radiate 9f, 10f and 12f signals to the receiver.

5. A suitable receiver as disclosed in the '816 patent, is illustrated in Figure 7:



The receiver system takes the form of a three-channel configuration in which transmitted signals of 9f, 10f and 12f are received. Incoming signals of 9f which successively impinge upon the antenna 19, are commutated into 9f memory oscillators 24, 27 and 28. Each of these memory oscillators "memorizes" the phase of the incoming signal from a given station, as a result of the action of a phase discriminator 23. The discriminator 23 effectively phase-locks each oscillator respectively to the instantaneous phase of the incoming burst of 9f. By this means, a stored replica of the phase of the incoming carrier frequency from each of the three stations is retained, and available for signal processing after the transmission interval for the respective burst of 9f has ended.

The 9f signals generated by the memory oscillator in each vertical tier are first applied to dividers 29, 30 and 31 to obtain a 3f signal and then to another set of dividers, 32, 33 and 34, respectively, to derive a signal of frequency 1f. The dividers 29, 30 and 31 are under the control of a mixer 35 while the dividers 32, 33 and 34 are under the control of a mixer 38. Each of the mixers 35 and 38, is supplied with a stored replica of the 9f signal, from the respective station, at the appropriate time. During the period when 12f is being received, the mixer 35 derives the "beat" frequency between 9f and 12f. The 3f output waveform of the mixer 35 thus derived is applied to one of the dividers 29, 30, 31 in the proper sequences. During the time interval when 10f is being received, the mixer 38 produces the "beat" frequency between 9f and 10f. The 1f output waveform of the mixer 38 is applied to the input of either divider 32, divider 33 or divider 34 at the proper time in the signal processing sequence.

The phase difference between the memorized replica of the 9f signal received from station A, and the memorized incoming signal from station B is observable on a fine phase indicator 41. The phase difference between the 1f frequencies developed by the dividers 32, 33 is rendered visually observable by means of a coarse phase indicator 42. The system also includes a fine phase indicator 43, and a coarse phase indicator 44, connected between two other adjacent vertical channels in the receiver.

The incoming 9f signals from the three stations arrive at the receiver in sequence. As a result, means must be provided for commutating the incoming 9f signals into the particular memory oscillator intended to process signals from a specific station. As shown, oscillator 24 must always receive and memorize the phase of the burst of 9f arriving from station A, oscillator 27 must sense and store the phase of the incoming burst from station B, and oscillator 28 must sample and phase-lock to the phase value associated with the incoming carrier burst of 9f arriving from station C. In order to commutate the sequentially arriving 9f signals into the correct oscillator, the system employs a rotary switch 26

which takes the form of a conductive rotor sequentially engaging three conductive arc segments. Each of the conductive arc segments is connected to the input of one of the 9f memory oscillators, in order to permit the spinning rotor to apply each of the incoming 9f signals to the appropriate memory oscillator. The rotor element of switch 26 is mechanically ganged to the rotor elements in a number of other switches. One of these switches is used to commutate the output signal from the mixer 35 into the dividers 29, 30 and 31 during the correct time interval in the signal processing cycle period. The output signal from the mixer 38 is also commutated either into divider 32, 33 or 34 as required, by means of one of the switches which is ganged to the rotor of the switch 26. The position of the spinning rotor must be synchronized at all times with that of a spinning rotor which is employed at the shore stations (*i.e.*, transmitters) to commutate 9f, 12f and 10f signals out onto the air. This is accomplished by a synchronizer 40a and a synchronous motor 25a, which act to ensure that the receiver and the transmitter are always precisely correlated.

6. The receiver shown in Figure 7 utilizes frequencies of 9f, 10f and 12f. Assuming a fundamental frequency of 1.133 khz, the basic navigation frequencies are 10.2, 13.6 and 11⅓ khz. Using these frequency values, the memory oscillators 24, 27 in the first two vertical tiers of the receiver are both memorizing the phase of incoming 10.2 khz. signals. The fine phase indicator 41 will provide an indication of the phase difference between the two incoming 10.2 khz. sinusoidal signals. The frequency of the output signals produced by the first divider in each tier will be 3.4 khz. A phase indicator connected between these two dividers 29, 30 would read the phase difference between the two 3.4 khz. sinusoidal analog waveforms. The lowermost dividers 32, 33 supply input signals of 1.133 khz. to opposite sides of a coarse phase indicator 42.

The readout on coarse phase indicator 42 corresponding to the 1.133 khz. wave length would represent a position in a 72-mile-wide lane. The indications which appear on the phase indicator 42

are nine times "coarser" than those which appear on the fine phase meter 41. The values which appear on coarse phase meter 42 are indicative of a position in a 72-mile-wide lane on a hyperbolic grid, and those of fine phase meter 41 are indicative of a position in an 8-mile-wide lane. Together, the meter 42 identifies which of nine lanes, each 8 miles wide, the receiver is in and meter 41 indicates the position within the particular 8-mile-wide lane.

7. VLF energy radiated out to a remote receiver is susceptible to many variations between the time it leaves the transmitter and the time it is received at the receiver. Such things as earth surface conductivity, diurnal variations and many other factors which vary from place to place over the earth's surface will have an effect on a radio wave. In addition, aberrations of unknown origin and unpredictable duration are also encountered and either effect the radio wave or may interfere with any reception of the signal. As a result, although signals may be phase-locked when transmitted, they may be out of phase due to factors other than the time difference of propagation by the time they are received.

8. (a) The '816 system has a limited capability to provide lane identification in the presence of noise and propagation error. It does so in the following manner. The 9f signals are fed respectively to the phase-locked oscillators 24, 27 and 28. These oscillators are driven by the incoming 9f signals and, therefore, they effectively "track" the 9f both as to frequency and phase, and, since their output is a clean, "noise free" signal, they are referred to as "tracking filters." Adequate tracking filters, such as oscillators 24, 27 and 28, were known in 1954 and were capable of producing relatively clean signals. The fine control is then obtained by phase-comparing these signals at meters 41 and 43. The coarse lane identification is accomplished by two stages of controlled $\div 3$ division as follows. Referring first to signals from the A station by itself, the 9f output from oscillator 24 is divided by 3, by divider 29, and again by 3, by divider 32. The outputs of dividers 29 and 32, however, would be ambiguous if they were not further controlled. Thus, the divider 29 can be driven by any one of each third cycle of

oscillator 24, and divider 32 can be driven by any one of each third cycle of divider 29, and without further control the precise cycle which is to do the driving is arbitrary. The way it is controlled in the '816 is first by developing a 3f signal from beating the 9f and 12f signals from station A at mixer 35. The 9f used for this is the output of the oscillator 24 which, in effect, is a stored representation of the 9f from station A. The 12f used is the 12f output of amplifier 21.

(b) The developed 3f beat signal is injected into the divider, and comprises an overiding or "notching" 3f signal which can effectively cause the 3f output to move over so as to receive its driving force from a different cycle of each group of pulses of the train. This shifting, however, will not take place unless the injected 3f signal is more than 60° out of phase with the previously existing 3f output (or 180° out of phase with the 9f). If the injected 3f is 60° or less out of phase, after the injected 3f goes off, the divider will move back and resume its alignment with the same cycle of the 9f group as before, just as though the 3f signal had never been injected.

(c) The same thing happens in the next division from 3f to 1f. Thus, if an overriding or "notching" 1f signal is injected into the divider (*e.g.*, divider 32) which is more than 60° out of phase with the existing 1f output of the divider (or 180° out of phase with the 3f), the divider will move over so as to be driven by a new one of the 3f pulses. And if the injected 1f is 60° or less out of phase, the 1f divider will move back and resume its alignment with the same 3f pulse it was on before.

(d) In this way the dividers 29, 30, 31, 32, 33 and 34 are controlled or "notched" under the influence of all three transmission frequencies from each station to cause the coarse phase indicators 42 and 44 to be driven in correspondence with a given notch of the 9f, thereby permitting the coarse meters to be calibrated so as to read out the whole number of the lane. Once the "notching" is correctly established, the dividers effectively store the lane information for periods during which the 10f and 12f signals are not on. In fact, the system will "integrate" indefinitely without the 10f and

12f as long as the 9f is not interrupted long enough for the tracking filters to wander too much. Oscillators in use in 1954 were good enough to tolerate 5 minutes' silence on the 9f without loss of lane provided straight and level flight was assumed. In fact if the 9f skips a lane or two in a period of no signals, when the signals come back on the air, the 12f and 10f, when employed separately in the foregoing manner to produce the notching 3f and 1f signals respectively, will return the coarse meter 42 back so that it will read out the correct 9f lane provided the undetected drift does not exceed 4½ 9f lanes during the period of no signals (*i.e.*, ± 36 n.m.). Similarly, a short term random aberration in the signals can cause an erroneous lane reading, but after the aberration passes, the system will return to accurate navigation in the same way.

(e) The same considerations are applicable to long term aberrations resulting from, for example, diurnal variations of frequency dispersion. If, as an example, there is an aberration in the 9f signal from station A, the divider 29 will be driven by the 9f and the aberration will also appear in the output of the divider 29 with the 3f exactly in alignment with the driving cycle of the 9f. At mixer 35, the incoming 12f is assumed to be without error. This means that the only erroneouus phase shift is in the 9f and when the 9f and 12f from station A are mixed (heterodyned) the erroneous phase shift will carry through without change into the beat note, and the 3f output of mixer 35 will be in error by an amount dependent on the magnitude of the original aberration. Such an error in the 3f, however, is immaterial if it is short of the 60° in the 3f noted above which is required to shift the 3f output of the divider 29 to a different driving cycle of the 9f. Assuming that it is, after the 12f goes off, the divider 29 will remain in the same "notch," just as if the mixer 35 had not injected any signal. Similarly, the divider 32 (which is driven by the output of divider 29) remains unchanged after the departure of the transient signal from mixer 35.

The same analysis applies to the next level of division from 3f down to 1f. Here the injected 1f signal from mixer 38 comes in after the mixer 35 goes off, and as above, it must likewise be more

than 60° out of phase with the output of divider 29 on the 1f scale (or more than 180° out of phase on the 3f scale) to cause divider 32 to adopt a different one of the three pulses from divider 29 as its driving force.

In the '816, the 1f difference frequency (*i.e.*, the beat note of the 9f and 10f at the output of mixer 38), is used only to identify which notch of the 3f is the correct one. This means that it can tolerate substantially more (*i.e.*, three times the aberration) without throwing the system into error than would be the case if only the 1f difference-frequency were used to identify the 9f notch. A 9 to 1 system can tolerate no more than 20° aberration in the 9f; however, in the '816 by use of the 3f difference frequency (*i.e.*, the beat note of the 9f and 12f at the output of mixer 35), the correct 9f notch can be identified first on a 1 to 3 basis in the presence of 60° aberration in the 9f, and the 1f can identify the correct 3f notch also on a 1 to 3 basis and also in spite of a 60° aberration in the 9f.

9. In summation, the '816 patent describes a hyperbolic radio navigation system wherein three phase-locked, harmonically related frequencies from each of two (or more) spaced stations, are transmitted and received in a synchronized manner, and then processed in the receiver to provide a "raw" LOP comprising a fractional lane readout which is dependent on two of the signals (*i.e.*, the 9f from two stations), and a coarse readout of the whole number of the lane which is dependent upon the six received signals from two stations.

The receiver of Figure 7 is designed to tell a navigator, through the readout of meters 41 and 42, which lane out of a group of nine lanes the receiver is in and where in the particular lane the receiver is. If the navigator knows his position to an accuracy that places him in a group of nine lanes, the meters 41 and 42 will read his position without ambiguity. If the navigator does not know which group of nine lanes he is in, the patented receiver is not capable of supplying that information.

10. (a) A commercial Decca Decometer could be used for meters 41 and 42. The meters might display a "raw" (*i.e.*, uncorrected for aberrations, etc.) hyperbolic LOP in numeric or digital form. Defendant's contention that claim 1 requires that the readout must occur, or be updated, on a recurrent cycle which, in seconds, is the reciprocal of the fundamental frequency is in error. What is meant by the statement at col. 1, line 49, and the corresponding statement in claim 1, that the phase difference indicator would indicate "the difference in time of propagation which indicator has a recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental frequency" is that the magnitude of the time difference of propagation indicated as the receiver passes through successive 1f lanes, will be the reciprocal of 1f. If, for example, the fundamental is 1.133 khz., as it is in the accused system, the time difference of propagation reflected by the meters would be 0.8824 milliseconds, as the receiver passes from one 1f lane to another 1f lane.

(b) The mathematical expressions in claim 1 of the '816 patent for the output signals radiated by the transmitters contain one or more radian constants. As explained at col. 11, line 9 and at col. 1, lines 33-39, and as one of ordinary skill in the art would readily recognize, each frequency is harmonically related and each is locked in phase relative to the fundamental but the exact time relationship is unimportant so long as it stays the same. The arbitrary phase change may be made in the radiated signals so long as equal phase changes are introduced in the receiver. These arbitrary phase changes are recognized in the symbolic notation which expresses the phase relationships of the frequencies by the constants included in that notation. These constants may range from zero, *i.e.*, no arbitrary phase change, up to any value. In other words, the '816 patent recognizes that an arbitrary phase change may be introduced, the only requirement being that it be used uniformly throughout the system.

(c) The transmission hardware and alignment procedures of the '816 were standard for Decca at the time and the feasibility of the

transmitter had been proven and was well-known prior to 1954. The use of VLF (in the 10-14 khz. band) on equipment such as that described in the '816 also was feasible in 1954. Although the embodiment of Figure 7 was never actually built and sold, the related structures of Figures 8 and 9 were. The reason why Figure 7 was not was due to the lack of Governmental authority to build and operate antennas suitable for VLF transmission. Such antennas are very large and their transmission interferes with nearby telephone transmission. Plaintiff, at one time, spent a large sum of money for equipment for VLF antennas on the expectation that the granting of such authority was imminent, but the expectation proved to be false and the plan had to be abandoned.

(d) Switching of transmissions was illustrated in the '816 by means of a rotary "commutator" switch. The '816, however, lays no stress on this form of switching. Any type of timed switching would do as well and comes within the purview of the '816 disclosure.

(e) The transmission pattern in the '816 is altered periodically for synchronization purposes. The patent, however, makes it clear that other methods of synchronizing switching could be used (col. 5, lines 39-43) and that what was needed was some form of "modification of the transmission for signalling purposes" (col. 9, line 21) so that the receiver would be able to line up correctly in synchronism with the received signals.

(f) Since atomic clocks were not available in 1954 the transmissions in the '816 were performed in a Master/Slave relationship, with the precise timing of the slave transmissions being controlled directly by transmissions from the master. The '816 patent, however, lays no emphasis on this detail and its broad statements of the invention at col. 1, lines 27-44, and col. 3, lines 51-69, merely specify the phase and harmonic relationships and the need for synchronism. None of the claims in issue is limited to the specific Master/Slave relationship disclosed in the patents.

(g) The data processing in the '816 is strictly analog. Thus, the phase angle of the 9f from the A station is compared to the phase angle of the 9f of the B station and the meter 41 reads out the difference in a strictly analog manner. Likewise, the 3f and 1f "notching" signals perform their functions of developing the lane information which is then stored in the dividers and read out on meter 42 in a strictly analog manner. As of 1954, the man skilled in this art, for all practical purposes, had only analog means available to him.

(h) Plaintiff had long been aware of the existence of propagation aberrations of various sorts, and, by 1947, it was already publishing corrections to users of its navigation systems. The '816, however, was concerned with minimizing the effect of propagation aberrations on the accuracy of the lane identification and made no attempt to provide for correcting the fine control to compensate for propagation dispersion. Thus, the '816 provided a simple "raw" position based on crossed "raw LOP's." Such information can be employed for rendezvous purposes and known propagation errors can be applied to it for navigation. Also, the '816 equipment can be set up at a known location and an accurate correction for propagation errors can be made at that time simply by comparing the readout of the equipment with the known position. Thereafter, if the equipment is monitored or used for a while, the predictable propagation errors can be established, at least on a temporary basis.

11. (a) Accused to infringe is the Omega VLF Navigational System sponsored by the U.S. Navy for world-wide use. That system contemplates Omega transmitters to be located at the following eight locations:

La Moure, North Dakota
Haiku, Hawaii
Bratland, Norway
Liberia
La Reunion Island (France)
Argentina
Tsushima, Japan
Australia

Agreements and/or treaties have been concluded with Norway way, Japan, Argentina and Liberia under the terms of which stations may be installed in those countries.

(b) Defendant has procured all of the constituent elements for eight Omega transmitting stations, *i.e.*, 16 transmitters, nine timing and control sets, and eight antenna tuning sets, otherwise designated as follows:

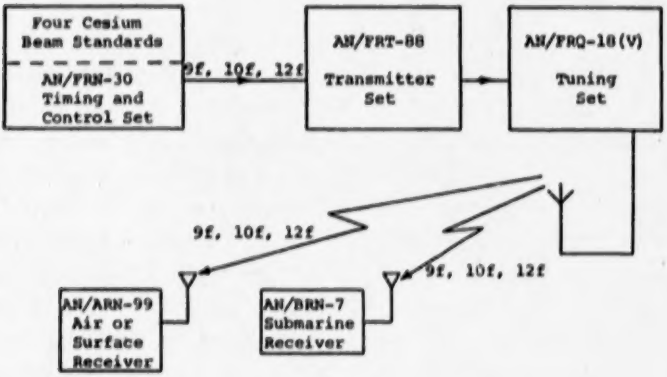
1. Omega Timing & Control Set AN/FRN-30
2. Omega Tuner AN/FRQ-18 (V)
3. Omega Transmitter AN/FRT-88

By the time of trial, Omega transmitter stations had been completed, and were operating at La Moure, Haiku and Bratland, Norway, and construction was under way at La Reunion, Tsushima and Argentina. Equipment for stations not yet under construction is stored at Great Lakes, Illinois. The only parts of a complete transmitter system not stored at Great Lakes are the tower and a wound helix coil. The tower is purchased when the station is to be constructed and the helix coil is wound on site.

(c) Defendant has procured Omega receivers AN/ARN 99 and AN/BRN-7. The ARN-99 receivers are for use with surface and air craft while the BRN-7 receivers are for submarines. There appears to be no dispute that these rece[illegible] been installed in craft owned by the United States and that these receivers have been used to receive signals both from any combination of two of the three operating Omega stations and from all three stations for navigational purposes, and that this has occurred both within and without the territorial limits of the United States.

12. The Omega system is designed to provide transmissions of 9f, 10f and 12f signals from eight stations spaced to provide worldwide coverage. Each of the stations includes three major components, the AN/FRN-30 Timing and Control set, the AN/FRT-88 Transmitter set, and the AN/FRQ-18 (V) Tuning set for the transmitting antenna. The timing and control set includes a set of four redundant cesium beam frequency standards. These cesium standards are ultra-stable atomic clocks, which exploit the

phenomenon of atomic resonance, and attain an accuracy of one part in 10^{11}. The transmitter set includes audio power amplifiers, and the tuning set includes a number of relays, which may be selectively closed to direct the 9f, 10f and 12f to the proper tap on a helix coil from which they are commutated out onto an antenna system. The two types of mobile receivers, the AN/ARN-99 and the AN/BRN-7 complete the Omega system. The following block diagram illustrates the basic system:



13. (a) The Omega frequencies are in fixed multiple phase relation, and therefore are harmonics of a fundamental frequency f as follows:

10.2 khz. = $9 \times 1.1\frac{1}{9}$ khz. = 9f

13.6 khz. = $12 \times 1.1\frac{1}{9}$ khz. = 12f

11.33 khz. = $10 \times 1.1\frac{1}{9}$ khz. = 10f

These three frequencies are phase-locked to Universal Time so that all three simultaneously cross zero phase with a positive slope at exactly 0000 hours. At the transmitters the necessary fixed multiple phase relation is obtained by dividing down and synthesizing from a higher frequency generated by the extremely stable atomic clock which has an output of 1 mhz. The 1 mhz. out-

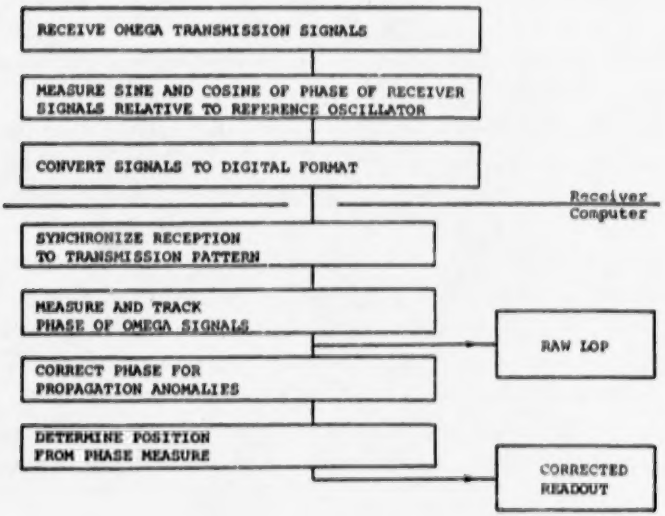
put is divided down to 816 khz., which is an integral multiple of the three Omega frequencies, and that signal is then subjected to a series of digital divisions to produce the correct values to be radiated from the antenna.

(b) The Omega pattern repeats itself with all frequencies rising through zero amplitude at the start of each 30-second epoch from zero Omega time, and a 30-second epoch pulse is used to bring them all into alignment at that instant. If any of the dividers in a given transmitting unit somehow loses phase alignment, as they can on occasion, a warning light comes on, the unit is shut down and the transmissions have to be realigned by the use of a new epoch pulse from another equipment. At the start-up of a new transmitting unit, the alignment is done by starting an atomic clock at an existing station and synchronizing its 30-second epoch pulse with that station, then flying the clock to the new station and starting the transmitting units there with their clocks in synchronism with the 30-second epoch pulse from the original station. The clock is then flown back and checked to make sure that it is still accurate. At each station, there are four such clocks, and each is constantly being checked against the others. If one of the dividers in one unit loses phase alignment, a reference signal from one of the clocks immediately indicates an error and the unit with the error is automatically turned off and reset using the 30-second epoch pulse of one of the other units.

(c) The Omega transmitter system is designed to compensate for any change in antenna capacitance or detuning occasioned by weather changes, snow on the ground, wind forces, and a large number of other factors. Precise control is indispensable because any shift in the antenna capacitance results in a large drop in the radiated output power. A feed-back control system samples the values of the current and voltage which are present in the antenna line and from these samples, corrections are made. The Omega system also constantly monitors the phase of the outgoing carrier bursts of VLF and corrects any error discovered. Provision is also made for checking the waveform at numerous points in the system.

(d) The Omega stations radiate their signals in a distinctively altered transmission pattern to facilitate station identification. This is accomplished by the transmission segments having slightly different durations, and the durations are coded so that a receiver can thereby identify each individual station.

14. (a) The basic Omega receivers are illustrated in the following block diagram:



(b) Each receiver uses a reference oscillator to measure the difference in phase between itself and the incoming CW bursts. This oscillator is not as precise as the atomic clock of the transmitting stations, and thus may drift. Also, when the Omega receiver is turned on the oscillator zero time is unknown. However, the fact that the receiver oscillator is not time-synchronized to universal time zero is unimportant, for either the measurements from two stations can be differenced, thus subtracting out the arbitrary oscillator zero time, or the error in receiver oscillator zero time can

be calculated, and its drift measured and tracked, thereby permitting single station phase measurements. Position fixing by the first method, using two-station, difference measurements, is referred to as hyperbolic navigation; position fixing by the second, which uses the phase measurements from each station, is called circular or rho-rho navigation.

(c) The receivers are of a single conversion heterodyne design using an RF section in which amplifiers, filters and mixers are among the components making up the hardware. The output of these receivers are digital signals which are fed into a militarized general purpose digital computer. The computer is programmed to perform a whole host of functions including selection of the optimum orientation for the loop antenna, synchronization of the incoming signals with the computer routines, measurement of the phase of the incoming signals, compensation for the motion of the vehicle, prediction and compensation for imperfection in the received waves, compensation for the oblateness of the earth and conversion of data to latitude-longitude. Some of these functions are performed in the burst filter, some in the tracking filter and some the Kalman filter, all of these filters forming a part of the program stored in the magnetic core of the computer.

(d) A three-channel Omega receiver operating in the hyperbolic mode has the capability of resolving lane ambiguities up to 72 nautical miles. Operating in the rho-rho mode, it automatically computes circular lanes out to 144 nautical miles. The Omega system using the ARN-99 receiver uses what may be called a modified rho-rho method in that it determines its initial position by phase differencing the signals from three stations in the hyperbolic mode; thereafter, as the computer becomes more confident of the oscillator drift calculation, its operation approaches rho-rho where signals from a single station are all that is required. The BRN-7, however, makes no use of the rho-rho mode of navigation, and always requires signals from three stations to get a position fix and signals from two stations to establish a LOP. Both types of receivers, when operating in the hyperbolic mode, process the

signals in the same way and both have the capability to display, at any time, an uncorrected "raw" hyperbolic LOP.

15. The 9f, 10f and 12f signals or carrier bursts from the Omega stations must be synchronized with the receiver's own repetitive internal timing cycle which is cyclic and repeats itself once every 10 seconds. The importance of verifying synchronization is that the computer will not initiate the sequencing of any of its computational cycles, or correctly produce the myriad of critically-timed downstream gating impulses required by its logic circuitry, until it has determined where the leading edge of the incoming burst from the station is occuring with respect to its own repetitive 10-second cycle. The receiver uses a mathematical technique called differential correlation involving "short slot" and "long slot" sums to establish synchronization of the receiver's cycle with the incoming transmission. It is the periodic distinctive alteration in the transmission pattern that signals the receiver as to the correct timing of the sequence. The particular method by which the computer processes the incoming pattern of signals to achieve synchronization is immaterial.

16. As the 9f, 10f and 12f signals arrive at a receiver, they are heterodyned down to a common 1f or 1.1⅓ khz. (this frequency choice is merely a convenient 1f frequency and bears no specific relationship to the 1f used in the navigational problem). The heterodyning, however, is done by mixing with locally generated signals having a fixed phase relationship. Therefore, the 1F retains the phase relationships of the incoming 9f, 12f and 10f frequencies without change. Accordingly, when the different transmissions from the respective stations are phase-compared to a local oscillator oscillating at 1.1⅓ khz., the respective phase relationships of all the incoming frequencies can be determined and measured. At this point, the phase information (*i.e.*, the difference in phase between the incoming signal reduce to 1.1⅓ khz. and the local oscillator), is measured and the value is then translated into a series of electrical pulses representing binary digits which are then fed into the computer where they are stored in the memory core in

the form of discretely magnetized areas, the stored digital value of which represents the phase of the incoming signal. In this connection, the phase information remains continuously available for use by the computer, according to its permanently maintained, built-in program.

17. The manual for the BRN-7 describes the functions of the burst filter, tracking filter and Kalman (combinational) filter as follows:

> 3.1.1.4.7 *Burst Filter:* The function of the Burst Filter is to collect the sine and cosine receiver outputs and calculate the first crude phase measurement as well as an estimate of its credibility based upon the signal-to-noise ratio (from Noise Estimation). It is the combination of the Burst Filter processing and the correlators in the receiver which constitute that referred to as the correlator ratio detector. The resultant phase is corrected for phase errors introduced by the hardware. The measurements, phase, and estimate of validity are transferred to the phase differencing equations before submittal to the Tracking Filters.
>
> * * * * *
>
> 3.1.1.4.10 *Tracking Filters:* Since there are eight possible transmitting stations and three frequencies for each station, there are 24 Tracking Filters. Each Tracking Filter receives an input from the phase differencing equations once every 10 seconds. After differencing, the input to the Tracking Filter consists of a measure of phase difference and a computed variance of this measurement. This measured phase difference is then compared (or weighted in a statistical sense) with an estimated value of phase difference which the Tracking Filter computes based upon previous measurements. From this comparison a new estimate of phase difference is computed. ***
>
> 3.1.1.4.11 *Combinational (Kalman) Filter:* The outputs of the Tracking Filters are well-filtered value of phase difference along with the estimates of phase difference variance

and phase difference rate variance. It is within the Combinational Filter operations that the outputs of the Tracking Filters are statistically, optimally combined, arriving at "best" error estimates of system position, velocity, and oscillator drift. The error estimates of system position are transmitted to the navigation equations as rotational corrections about the axes of the reference triad while the velocity error estimates are transmitted to Velocity and Heading Processing as corrections along the axes. The error estimate in oscillator drift measures the phase and frequency differences between the local oscillator in the receiver and the transmitted OMEGA signals.

The Combinational Filter is also used for lane determination. Lane determination (laning) is accomplished by use of a multiple state vector technique. The wavelength of each frequency determines a lane within which the receiver position can be determined. The widths of these phase difference lanes are 6, 7.2 and 8 miles, corresponding to the frequencies of 13.6, 11⅓, and 10.2 khz, respectively. At intervals of 72 miles these lanes repeat, thus defining a larger three-frequency lane width. Resolving the known phase (position) from each frequency into the larger lane is referred to as resolving the lane ambiguity. A three-channel OMEGA receiving set operating in the hyperbolic mode has the capability of resolving lane ambiguities up to 72 nautical miles.

18. (a) Lane identification, for purposes of developing a raw hyperbolic LOP, is made in the Omega receivers by a process involving both frequency differencing and phase comparisons. The receiver computer has accumulated in its storage, within the synchronization period at the start, sufficient information about the phase and sequence of the incoming 9f, 10f and 12f signals from all received transmissions to be able to frequency difference them or to phase compare them as required. Naturally, this information is constantly being updated with the passage of time and is available

for determination of a raw hyperbolic LOP in the lane identification mode at any time after synchronization is completed. For each station by frequency differencing the 9f and 10f, 10f and 12f, and 9f and 12f in pairs, difference frequencies of 1f, 2f and 3f respectively can be generated. These difference frequencies from two different stations can then be phase compared so as to locate the receiver within the corresponding 1f, 2f or 3f zones, which on the base line between the two stations would have widths of 72, 36 and 24 miles respectively. This is "coarse" indication of receiver position within the 72 mile-wide zone (at the base line) corresponding to the Omega 1f fundamental frequency of 1.133⅓ khz. The digital computer in the receiver performs these operations repeatedly and rapidly, ultimately determining the "coarse" lane identification, *i.e.*, locating the receiver in one of nine 9f lanes in the 1f 72-mile-wide zone.

(b) At this point, the computer will now take single frequency measurements on the 9f from the two stations and, by a phase comparison, determine where the receiver is in the previously identified 9f lane. When this has been accomplished, the receiver will display a digital LOP readout, as, for example, 985.75, the numbers to the left of the decimal being indicative of the 8-mile lane and the numbers to the right, indicating the location as a percent of that 9f 8-mile-wide lane.

(c) Thus, the accused receivers are capable of resolving lanes to ± 36 n.m. based on receiving all three frequencies, 9f, 10f and 12f, from each of the stations. If the navigator does not know his position within ± 36 miles, the Omega system cannot supply that information. But assuming that he does, both types of receivers are programmed to display, upon command, a raw hyperbolic LOP which identifies which lane out of a group of nine the receiver is in and where the receiver is in that lane. It is by a process of differencing the frequencies and comparing their phases that the receiver arrives at a determination of which lane it is in. Through a phase comparison of the 9f signals, its position in that lane is ascertained.

(d) Both in determining its original position in a 72-mile lane,

and at other times, the computer section of the receiver utilizes a mass of other data to arrive at a solution. For example, stored in the memory of the computer is such information as the coordinates of each Omega station and values of surface conductivity and correction factors which compensate for variations in the propagation velocity affecting the radiation path between each Omega ground station and the receiver. The computer is also constructed to receive, and utilize, velocity related rate-aiding signals, such as inertial velocity, doppler velocity, and true airspeed, as sensed by external sensors.

19. The Omega navigational system is readable on claim 1, as follows:

Clause 1.

A hyperbolic radio navigation system in which a position line is determined by indicating the difference in the time of propagation to a receiver of signals emitted from two stations in known spaced geographical positions,

Omega obviously employs the hyperbolic navigation technique to resolve the problem of lane identification. Both of the accused receivers are equipped to read out a raw *hyperbolic* LOP. This means that the position line is determined by indicating the difference in time of propagation to a receiver of signals emitted from two stations in known spaced geographical positions.

Clause 2.

wherein three signals are emitted from a first station satisfying the respective phase conditions, given in radians of angle $n_1 w_0 t + \alpha_1$, $n_2 w_0 t + \alpha_2$ and $(n_1 + 1) w_0 t + \alpha_3$, and three signals are emitted from the second station satisfying the respective phase conditions $n_1 w_0 t + \alpha_1 + k$, $n_2 w_0 t + \alpha_2 + k$ and $(n_1 + 1) w_0 t + \alpha_3 + k$, wherein n_1 and n_2 are integers, w_0 is 2π multiplied by a fundamental frequency in cycles per second, t is time in seconds and α_1, α_2, α_3, and k are constants,

The phase conditions of Omega's 9f (10.2 khz.); 12f (13.6 khz.); and 10f (11⅓ khz.) answer to the above analytical expression. They are transmitted in such a way that all frequencies cross zero

amplitude, rising at zero Omega time which means that all of the constants in the above expression are zero. Nothing in the '816, however, requires these constants to have any particular value, all that is necessary is that they be constant. They are in Omega.

Clause 3.

the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other station,

In Omega no two stations transmit the same frequency at the same time. This is essential because, at the receiver, the reception of two such signals of the same frequency simultaneously would simply sound like one and the phase information would be a combination of the two rather than the phase information of either one. Accordingly, the switching as defined is necessary and Omega meets this limitation.

Clause 4.

and the transmissions being distinctively altered periodically for synchronizing switching means at the receiver with the switching of the transmissions and

In the Omega pattern, the respective CW segments have slightly different durations which are coded for the purpose of synchronizing switching means in the receiver. This is clearly a periodic "distinctive alteration" in the sense intended in '816.

Clause 5.

wherein the receiver comprises means for receiving the radiated signals,

Omega obviously has this.

Clause 6.

switching means which are synchronized by the distinctive alteration in transmission and which are arranged to separate the received signals from the two transmitters,

Both of the accused receivers have switching means at the receiver synchronizer to the transmission pattern. The switching is done by "gating" and by circuit sequencing in the computer, con-

trolled by a clock in the computer, which routes the digital phase information of the separately received signals to the appropriate storage locations in the core.

Clause 7.

and a phase difference indicator for indicating the difference in time of propagation which indicator has a recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental frequency,

The "recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental" refers to the fact that the "zone" in which lane identification is feasible is 1f wide, and beyond that distance the 1f phase difference indication, upon which the lane identification depends, repeats itself and is therefore ambiguous. The lane identification in both the ARN-99 and BRN-7, answers to this same definition. The two accused receivers are capable of resolving lanes to a maximum of ± 36 n.m., but only when all three frequencies from two stations are being received. The readout provides both the whole number of the lane (good to within ± 36 n.m.) and the fractional part within an 8 n.m. lane as a decimal number (to the right of the decimal point). This also corresponds to the published Omega charts which are set up to emphasize every ninth 10.2 lane, *i.e.*, a zone of 72 n.m. width on the base line.

Clause 8.

said indicator being operated by a fine control and a coarse control,

In Omega, the "raw" LOP is developed by a direct phase comparison between the 9f signals from two different stations. Such a comparison, however, only gives the "percent of lane" figure, *i.e.*, the numbers to the right of the decimal point on the display. The numbers to the left of the decimal point are developed by the frequency differencing mode to resolve the lane. The only effect of the frequency differencing mode is to develop the whole number of the lane, and in this sense (as in the '816), it is a "coarse control," while the percentage of lane is the "fine control."

Clause 9.

said fine control being dependent on a pair of signals derived from locally generated non-interrupted signals, one of which is phase-controlled by only one of the signals received from said first station and the other by only one of the signals received from said second station

In the accused Omega receivers, the "fine" LOP readout of the fractional position within a 9f or 10.2 khz. lane is derived from phase-comparing a 10.2 khz. signal from each of two stations. The way this is done is first by receiving the signals sequentially. When each comes in it is phase-compared to a local oscillator and its phase difference is extracted therefrom and converted to a pulse train representing the digital value of the phase difference. This pulse train is a "locally generated signal" and it is then fed to the computer and stored in the form of discrete magnetized areas in the memory core. In this form it is in a continously available status. Thus, in the accused receivers, the phase information is effectively a "locally generated non-interrupted signal." Of course, the signal is up-dated periodically, as it must be in any system in which the receiver is moving. But the signal is "non-interrupted" in the sense intended by the patent in that it is continuously available for comparison to provide a "fine" indication whenever the operator calls for a raw LOP readout. Thus, in the accused receivers the fine control for the readout of the position in a 10.2 khz. lane is derived from locally generated non-interrupted signals from two stations. But for the fact that it is done digitally in the accused receivers and analog in the '816, the two systems are identical.

Clause 10.

and the coarse control being dependent on six received signals derived from the three different frequencies transmitted from each of the stations.

The accused receivers go into the "frequency difference" mode to resolve lanes and all three frequencies from two stations are needed to resolve the lane to a "zone" width of 72 n.m. by the frequency differencing and phase comparison techniques described in finding 18.

20. Claim 4 is as follows:

> A hyperbolic radio navigation system as claimed in claim 1 wherein, at each station, the various different frequencies are radiated in sequence.

There is no doubt that the Omega signals are radiated in sequence.

21. Claim 11 is as follows:

> A hyperbolic radio navigation system as claimed in claim 1 wherein there is provided a third transmitting station radiating signals satisfying the respective phase conditions given in radians of angle, $n_1 w_0 t + \alpha_1 + k_1$, $n_2 w_0 t + \alpha_2 + k_1$ and $(n_1 + 1) w_0 t + \alpha_3 + k_1$ where k_1 is a constant, the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other stations, and wherein the receiver is provided with two of said phase difference indicators, one indicator being arranged to indicate the difference in time of propagation of signals from the first and the second stations and the other being arranged to indicate the difference in time of propagation of signals from the first and third stations.

By using three stations, the Omega receivers are able to display a pair of LOPs from which a position fix can be obtained.

22. (a) Under terms of an agreement, Norway acquired the land for the transmitter site at Bratland at no cost to defendant. The United States supplied, at no cost to Norway:

> (a) All necessary electronic, communications and monitoring equipment.
>
> (b). Technical assistance for installation and initial operation.
>
> (c) Design information for construction of the station.

Title to all the equipment rests in the United States, but Norway retains sovereignty over the transmitter site. In addition, the station was to be operated by personnel designated by Norway, but trained at U.S. expense. The entire cost of construction, operation

and maintenance of the station was to be at U.S. expense. Norway was to be responsible for ensuring continuous operation of the station in phase with the world-wide Omega complex. The U.S. was to bear all costs and expenses for any claims resulting from operation of the station, including any legal expenses and any settlements. In fact, defendant was responsible for synchronization management of the Norway station at least during its first months of operation.

(b) The United States is also paying for the construction of the stations in Argentina and Liberia but not for the stations in La Reunion or Japan. However, defendant is supplying the equipment, without cost, at least to Japan, and title to that equipment is to remain in the United States.

(c) Operation of the Omega transmitter in Norway was initiated by flying an atomic clock to the transmitter to establish phase synchronization. Thereafter the operation has continued under monitoring control from the United States. The foreign transmitter sends out the Omega signals according to the Omega format previously established by defendant. The United States is the sole controlling and guiding force behind Omega.

Conclusion of Law

Upon the foregoing findings of fact, which are made a part of the judgment herein, the court concludes as a matter of law that claims 1, 4 and 11 of U.S. Patent No. 2,844,816 are valid and infringed. The amount of recovery to which plaintiff is entitled as reasonable and entire compensation shall be determined in further proceedings pursuant to Rule 131(c)(2).

United States Court of Claims

TRIAL DIVISION

No. 299-70 (filed: March 29, 1979)

DECCA LIMITED

v.

THE UNITED STATES

Patents; reasonable and entire compensation; active inducement of and contributory infringement; reasonable royalty; savings to infringer; patentee's loss of profits; delay compensation

Robert B. Russell, attorney of record, for plaintiff.

B. Frederick Buchan, Jr., with whom was *Assistant Attorney General Barbara Allen Babcock*, for defendant. *John Fargo* and *Vito J. DePietro*, of counsel.

OPINION*

Browne, *Trial Judge*: The court has held in *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F.2d 1070, 191 USPQ 439 (1976) that claims 1, 4, and 11 of O'Brien, *et al.* U.S. Patent No. 2,844,816, issued July 22, 1958 and owned by plaintiff, Decca Limited (Decca), are valid and have been infringed by defendant, the United States of America (the Government). The case is now before the trial judge for further proceedings under Rule 131(c) to determine the quantum of reasonable and entire compensation to which plaintiff is entitled under 28 U.S.C. § 1498 for the manufacture and/or use, by and/or for the Government, of the invention [system] described in and covered by the patent, without license or lawful right thereto.

* The opinion and conclusion of law are submitted in accordance with Rules 134(h) and 131(c)(2).

The patent in suit expired July 22, 1975; hence, the determination made herein fully and finally compensates Decca for all manufacture and/or use by and/or for the Government of the system described in and covered by the patent in suit, including all components thereof, from the first date of manufacture and/or use of the system and the components thereof by and/or for defendant and/or its suppliers to the date of expiration of the patent and, as to delay compensation, to the date of payment of the judgment.

It is found that Decca is entitled to judgment in the amount of $39,355,715 as reasonable and entire compensation, including delay compensation, to and including March 31, 1979, plus additional delay compensation at the rate of $5,436 per day for each day from April 1, 1979 to the date of payment of the judgment. The determination is based on the evidence of record, in the light of the applicable law, due consideration also having been given to the extensive pretrial proceedings, lengthy trial, and comprehensive post-trial submissions.

I. *The Patent*

The infringed patent relates to a hyperbolic radio navigation system in which two or more separate transmitting stations established at known fixed locations emit radio frequency signals which are sensed by one or more receivers (fixed or mobile) located at a distance from the transmitters. In this system of navigation, each receiver is designed to measure the time difference in arrival of the radio frequency signals from each of the transmitters, the time difference being a measure of the difference between the distances traveled by the signals from the respective transmitters to the receiver. In this manner, a line of position (LOP) on which the receiver is located can be identified. If radio frequency signals are transmitted from three or more stations, the signals received from one pair of stations are used to establish one LOP, while the signal received from a third station processed with the signal from one of the pair of

stations establishes another LOP. The intersection of the two LOP's provides a positive position fix which serves to pinpoint the exact geographical location of the receiver (and its platform) at a given time.

Claim 1 of the infringed patent is an "independent" claim. Claims 4 and 11 are each dependent upon claim 1 and are, therefore, of narrower scope than claim 1.[1] More specifically,

---

[1] "1. A hyperbolic radio navigation system in which a position line is determined by indicating the difference in the time of propagation to a receiver of signals emitted from two stations in known spaced geographical positions.

"wherein three signals are emitted from a first station satisfying the respective phase conditions, given in radians of angle $n_1w_0t+a_1$, $n_2w_0t+a_2$ and $(n_1+1)w_0t+a_3$, and three signals are emitted from the second station satisfying the respective phase conditions $n_1w_0t+a_1+K$, n_2w_0t+a+k and $(n_1+1)w_0t+a_3+k$, wherein n_1 and n_2 are integers, w_0 is 2 multiplied by a fundamental frequency in cycles per second, t is time in seconds and a_1, a_2, a_3, and k are constants.

"the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other station, and

"the transmissions being distinctively altered periodically for synchronizing switching means at the receiver with the switching of the transmissions and

"wherein the receiver comprises means for receiving the radiated signals,

"switching means which are synchronized by the distinctive alteration in transmission and which are arranged to separate the received signals from the two transmitters, and

"a phase difference indicator for indicating the difference in time of propagation which indicator has a recurrence cycle of time difference indication equal, in seconds, to the reciprocal of the fundamental frequency,

"said indicator being operated by a fine control and a coarse control,

"said fine control being dependent on a pair of signals derived from locally generated non-interrupted signals, one of which is phase-controlled by only one of the signals received from said first station and the other by only one of the signals derived from the three different frequencies transmitted from each of the stations.

* * * * *

4. A hyperbolic radio navigation system as claimed in claim 1

"wherein, at each radio station, the various different frequen-

claim 4 is limited to a system in which the multiple frequencies radiated from each of two or more transmitters are radiated in sequence. Claim 11 relates specifically to a system in which the signals are radiated from three transmitters and the timing of the transmission of the signals is coordinated.

Although all three claims (Claims 1, 4, and 11) describe the system in terms of apparatus, when the components are operated in the manner set forth in the claims, the combination is a *unitary* navigation *system*, the directional signal generating elements (transmitters) being fixed and the signal receiving elements (receivers) normally, although not necessarily, being mobile.

II. *Adoption of the Infringing Omega System*

The claims in suit have been infringed by a worldwide navigation system, designed, developed, built, and operated by the U.S. Government. The Government named it the Omega System.

The system as implemented by defendant provides a global navigation system by transmitting signals from eight permanent stations, each of which is located at a different place on the

---

quencies are radiated in sequence

* * * * *

"11. A hyperbolic radio navigation system as claimed in claim 1

"wherein there is provided a third transmitting station radiating signals satisfying the respective phase conditions given in radians of angle, $n_i w_0 t + a_i + k$ where k_i is a constant,

"the transmissions being switched in sequence such that the signals of each frequency are transmitted from one station during intervals of the transmissions of the same frequency from the other stations, and

"wherein the receiver is provided with two of said phase difference indicators,

"one indicator being arranged to indicate the difference in time of propagation of signals from the first and second stations and

"the other being arranged to indicate the difference in time of propagation of signals from the first and third stations."

[The format of the claims has been changed for easier reading and understanding.]

earth. The emitted signals are utilized not only by the defendant, but also by anyone having a receiver capable of receiving and processing the signals to determine virtually instantaneously the geographical position of the receiver and its supporting vehicle or craft whether on land, in the air, on or below water.

Defendant had contracted for and was in possession of all of the constituent electronic components[2] of all eight Omega transmitting stations prior to July 22, 1975 (except the antennae towers and helix coils for four stations not yet completed by that date). Defendant had also contracted for a production quantity of receivers for use with Government-owned surface vessels, aircraft, and submarines prior to July 22, 1975, and was already operating a number of such receivers by that time.

Defendant, to aid in the investigation of various radio navigation systems in the early to mid-1960's (including those in the low frequency (LF) and very low frequency (VLF) ranges), established a committee known as Omega Implementation Committee (OIC) to study and make recommendations for a navigation system which would provide worldwide coverage. The OIC completed its work, and on June 1, 1964, published its report entitled "Omega, A World-Wide Navigation System—System Specification and Implementation." Thereafter, the Government issued directives (SOR 34-01, dated July 24, 1964, and TDP 34-01, dated December 28, 1964), outlining its plans for establishment of the system. In March 1965, it was recommended that the Navy be designated to manage the project rather than placing the implementation in the hands of a private contractor.

The Omega System was to be established as a worldwide navigation system for nongovernmental, as well as Government, use. It was to be a replacement for the existing Loran A and Loran C low frequency (LF) systems, each of which had its

[2] Sixteen transmitters (two for each station), nine timing and control sets (one for each station plus one spare), and eight antenna tuning sets (one for each station).

limitations. On June 18, 1965, the Chief of Naval Materiel was charged with the responsibility for procuring, installing, and operating all things necessary to establish the Omega System.

Defendant took prompt steps to establish and operate a suitable transmitting station from which the three frequency Omega format signals could be emanated, and constructed receivers which would process the three frequency signals whereby the operability of the system could be definitely established. The signals were transmitted, received, and processed according to the Omega format by February 1966, thereby satisfying the terms of Claim 1 of the '816 patent. That use, however, was experimental and was not continued. Within the next few months, however, namely by June 1966, defendant determined that the Omega System would satisfy all of its requirements and proceeded to fully implement the recommendation of the OIC and the provisions of SOR 34-01 and TDP 34-01 by making the necessary plans to establish the system on a worldwide operational basis as soon as feasible, consistent with availability of funds and manufacturing and construction lead times.

III. *Initiation of Procurement*

The first step taken by defendant toward initiating procurement of property and materiel to build the Omega System was to decide, as a matter of policy, that it would be its own "prime contractor," rather than request bids for establishment of the system. In this way defendant hoped to save certain general and administrative costs, as well as design and engineering expense, which would otherwise be borne by a private contractor and for which the contractor would expect to be reimbursed by the Government. This saving was estimated to be approximately $10 million, based on an estimated total system cost of $90 million.

Having established the reliability of the Omega System not later than September 1967 by its own substantial testing, defen-

dant declared the Omega System operational[3] on October 24, 1967, and guaranteed its availability to the public for at least 1 year from that date.

Consistent with defendant's procurement planning, contracts were placed for all of the constituent elements necessary for the establishment of a total of eight permanent Omega stations and at least 140 receivers between June 1966 and June 1969. Defendant took delivery of and installed the first commercially-produced receivers on some of its submarines in June 1969. By July 22, 1975, the date of expiration of the '816 patent, defendant had placed four transmitting stations in operation and had received delivery of more then 60 receivers. All necessary equipment (except antennae towers and helix coils) had been delivered to the Government and all appropriated funds had been obligated for the four additional stations, but the four additional stations were not put into operation until after the patent expired.

IV. *The Taking*

In determining the quantum of reasonable and entire compensation under 28 U.S.C. § 1498, the actual date of the first and successive takings, if any, must be ascertained since the *value* of the rights taken by the defendant must be determined as of the date of the Government's taking of those rights. *Danforth* v. *United States*, 308 U.S. 271, 283 (1939). It is also necessary to establish the dates of takings for the purpose of determining the date (or dates) from which delay compensation is to be computed. The calendar year in which each of the takings occurred must be determined, since the delay compensation *rate* depends on the quinquennium in which each taking occurred. *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978); *Textronix, Inc.* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, 198 USPQ 378 (1978).

[3] The Government has referred to this phase as being "interim operational," and the stations are referred to as "interim operational stations."

The date of taking is easily determined when the Government contracts with an unlicensed third party for the manufacture and delivery of goods made according to a certain specification and delivered according to a prescribed schedule, as in *Leesona Corp.* v. *United States*, 198 USPQ 4, 14 (Trial Div., Ct. Cl. 1978). The date of taking is not as easily established, however, when the taking is based upon *use* of a *system* and *manufacture* of the *components* of the system. Due to the fact that the Government, in the present case, acted as its own prime contractor, determination of the dates of the takings is further complicated.

If the value of the right taken is equated to the cost of the components of a system, the taking is completed when title to all necessary components is vested in the Government. However, if the value is equated to savings resulting from use of the system, the taking is completed when the system is made publicly available for use.

Plaintiff suggests that the date of the first taking is June 18, 1965. This is the date on which defendant declared the Omega project a "CNM Designated Project."[4] Plaintiff contends that, as of that date, the defendant had committed a definite overt act which was sufficient to permanently foreclose plaintiff's market for economic exploitation of its patent. Plaintiff bases its argument on *Coakwell* v. *United States*, 178 Ct. Cl. 654, 372 F.2d 508, 153 USPQ 307 (1967), wherein it was stated that *liability attaches to the defendant if the same basic incidents to which liability attaches in the private sector are present.* More specifically, plaintiff maintains that a member of the private sector could have been enjoined from proceeding with the infringement as of June 18, 1965, when it published the details of the prospective infringement without first obtaining a license

[4] In designating the Omega project as a CNM (Chief, Naval Materiel) project, the Government expressed its intent to act as its own general or prime contractor and thereby absorb G & A (general and administrative) and similar burdens in its operating budget rather than allowing a contractor to include them in its contract price.

from plaintiff. Thus, by analogy, plaintiff relies on June 18, 1965 as the date of the defendant's taking of plaintiff's rights, since that is the date on which defendant published its intention to establish the infringing system.

Alternatively, plaintiff argues that the first taking was no later than February 1966, that being the month in which defendant began transmitting the required frequencies from a single station (Trinidad) and users, albeit not governmental users, began receiving and processing the Omega format, thereby completing the infringement initiated by defendant. This, plaintiff suggests, was the date which corresponds to a taking of plaintiff's patent rights in the "use" sense as that term is employed in 28 U.S.C. § 1498.

Defendant, on the other hand, asserts that there was no taking prior to June 1969. It is defendant's view that a taking could not have occurred prior to that date, since up to that date defendant did not possess any *production* model three frequency receivers capable of functioning within the scope of the patented claims, although it was transmitting the three frequency signals called for by the claims of the patent in suit and was using a combination of three single frequency receivers to receive the transmitted signals. The first taking occurred, according to defendant, only when certain Government-owned (commercially procured) ARN-99 or BRN-7 three frequency receivers were installed in Government craft or vessels and first received signals from the Goverment-operated transmitters aboard the craft or vessels in June 1969. The defendant's view of the date of taking is premised on the contention that the first taking occurred when the entire patented combination was first used by the United States. Since the court has previously held that the system cannot function without three frequency receivers, defendant maintains that it could not have infringed the system claims since its *commercially-procured* three frequency ARN-99 and BRN-7 receivers were not even in existence prior to 1969. Thus, defendant argues that 1969 is the earliest year in which taking could have occurred or did occur.

In addition to the alternative dates asserted by the parties as possible dates of taking, several other dates deserve consideration as possible dates on which takings could be deemed to have occurred. On June 1, 1964, for example, when defendant published the OIC report, it clearly evidenced defendant's then-existing intention to build the accused system. This was tantamount to notice to the world that the defendant intended to implement and pay for construction of the system and to not only use it but also to make it freely available to the public. Plaintiff's market for licensing, selling, or otherwise exploiting the patented system thus was effectively foreclosed and preempted throughout the world as of that date. This is especially true in light of the fact that the one system would be sufficient to provide navigation service to the entire world. Additionally, once the United States announced its intent to construct the Omega System, it is self-evident that other potentially-interested entities throughout the world would simply await that construction since the total cost of implementing such a system would be extremely high, and policing the use of the system by those without lawful right or license would be extremely difficult. This is primarily due to the nature of the patented system which makes it possible for any user, whether licensed or not, to take advantage of the transmitted frequencies by merely having possession of a three frequency receiver capable of functioning in the manner called for by the claims. In other words, the receiver is a "third leg of the stool."

Further, on July 24, 1964 and December 28, 1964, the United States issued SOR 34-01 and TDP 34-01, respectively, which papers outlined the planned implementation of the development phase of the Omega system. On March 4, 1965, the defendant, in implementing SOR 34-01 and TDP 34-01, first proposed the idea of eliminating the expense and need for a general contractor by performing the function of a general contractor itself. The issuance of the plan and implementation thereof constitute evidence of defendant's *intent* to take plaintiff's patented

system, and are also probative evidence of defendant's overt acts which led to its own direct infringement, as well as to its intent to actively induce others to participate in the infringement.

As early as June 1966, the Government solicited bids for procurement of three frequency receivers which were intended for use as components of the patented system, further evidencing its unequivocal commitment to a course of infringement.

Finally, October 24, 1967 stands out as a key date since that is the date on which defendant accorded its first four transmitting stations Omega operational status and publicly guaranteed availability and maintenance of the system on the air for at least one year.

This court, in the liability opinion of this case,[5] commented directly upon the taking of a license by the defendant. More specifically, the court states that a "use" by the United States, within the meaning of 28 U.S.C. § 1498, arises

> when the accused equipment is first *available* for use, *Regent Jack Mfg. Co.* v. *United States*, 167 Ct. Cl. 815, 337 F.2d 649 (1964) and it is when the *use occurs that a license is considered to have been taken. Irving Air Chute Co.* v. *United States*, 117 Ct. Cl. 799, 93 F. Supp. 633 (1950). It is this taking of a license, without compensation, that is, under an eminent domain theory, the basis for a suit under § 1498. Here, it is when the receiver receives the signal in the United States that there is a completed use of the system. (emphasis added.)

Thus, we have this court's ruling that at least one date on which the defendant took a license under the eminent domain theory was the date that a receiver (whether owned by the United States or a private party) first received the transmitted signals in the United States. If, for example, a private party received the signals transmitted by the United States, the latter is at least a

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[5] *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 567, 544 F.2d 1070, 1082, 191 USPQ 439 (1976).

joint infringer. This, according to the court, constitutes a completed use of the invention and hence serves as the date as of which the value of the property right is determined and at least one of the dates upon which the accounting period commences.

The facts in this case clearly establish October 24, 1967 as the date on which the first taking occurred, since that is the date by which all testing was completed and the transmitted signals were being received in the United States in accordance with a duly established and authorized navigation system. It is also the date upon which the real value of the system was manifested in an economic sense.

V. *Incremental Taking*

One element which makes it difficult to arrive at a realistic dollar value of the invention *at the time of the taking* is the stepwise implementation of the Omega system by the Government. First, it obtained multiple year funding of the program. Next, it put the system into full scale operation on an interim basis on October 24, 1967. Thereupon it placed large scale procurement for the purpose of achieving the ultimate goal of nearly 100 percent worldwide coverage. It had put four of the eight contemplated permanent stations into full scale operation prior to expiration of the patent but, meanwhile, it sequestered all of the necessary components for the remaining four permanent stations at the respective locations (with minor exceptions) prior to expiration of the patent, so that the last four stations could go on the air as soon as (or shortly after) the patent expired. Each year that went by after 1967, defendant increased its investment in the infringing system by procuring the components necessary to accomplish its total goal of worldwide coverage, thereby *increasing* the "book value" of the established system.

The term "taking" has been interpreted in so many different ways, depending on the nature of the property or right taken, that no single definition has been found which has universal applicability. Land taking cases (whether involving direct or

inverse condemnation) do not provide the necessary consistency or rationale to make them clearly applicable to all cases of taking of patent rights. A given tract of land, for example, is not ordinarily taken in increments. Patent rights, on the other hand, are sometimes taken in increments as a consequence of this court's holding[6] that the delivery date, rather then the contract date, is controlling in computation of reasonable and entire compensation for infringement of a product claim.

A threshold question in patent cases is the source of authorization for the taking. The taking in patent cases is normally incidental to or a consequence of an affirmative act of one or more persons charged with the responsibility of carrying out a legitimate governmental purpose, such as procurement of materiel. Nowhere has there been found a taking of a patent or patent rights comparable to the formal act of filing a "Declaration of Taking" or filing a condemnation suit in connection with the acquisition of the land. Even though the taking of patent rights has been referred to as the taking of a "compulsory license," such taking is not normally preceded by any statutory authority, formal demand or administrative proceedings. Planning and procurement of materiel for legitimate Government purposes normally does not entail acquisition of patent rights *prior* to either planning or procurement. Indeed, when competitive bidding procurement is initiated, the contracting agency proceeds on the premise that the lowest qualified bid must be accepted regardless of any patent liability consequences. At least in land taking cases (except by inverse taking) possession is seldom taken prior to acquisition of legal title or right of entry and even then, only after due proceedings are had. Not so in patent cases.

Since the Government and its contractors are protected by the doctrine of sovereign immunity from being enjoined from infringement or threatened infringement of a patent, they

[6] *See Tektronix, Inc.* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, 198 USPQ 378 (1978).

simply "march in" and "take" whatever rights are needed. Congress, in providing a monetary remedy for usurpation of the patent right by or for the Government, has failed to spell out the terms and conditions or the authority under which the Government or its contractors can bind the Government to compensate the patent owners for the taking. True enough, the fifth amendment provides that "just compensation" must be awarded for the taking. Congress has stated that such compensation, to be "just," must also be "reasonable *and entire.*"

The Constitution also provides that the Government may not acquire or dispose of property without an act of Congress. Rarely, if ever, does Congress expressly authorize the executive branch to acquire patent rights, either by purchase or by exercise of the power of eminent domain, in connection with the planning or procurement of materiel. Thus, it may be argued that *no one* has authority to take patent rights (*i.e.*, authorize infringement) in the course of planning for or procurement of the materiel unless it is established that such taking is necessary to carry out the legitimate governmental purpose of the agency involved.

Having held that the first date of taking occurred on October 24, 1967, and defendant's investment in the infringement having been virtually completed by July 22, 1975, the value increments over the 7-year and 9-months' period must be prorated. Moreover, transmission of the three frequencies by the Government from at least the four transmitting stations allowed, aided, and facilitated the practice of the invention all during that period by others who had in their possession and control receivers capable of processing the transmitted signals according to the Omega format.[7] The United States, therefore,

[7] The evidence clearly established that others had in their possession "breadboard" configurations of the three frequency receivers. These receivers were in use and capable of practicing the patented invention when not less than two of the stations began transmitting the infringing frequency format.

was guilty of both direct infringement and actively inducing infringement by others throughout the period from October 24, 1967 to July 22, 1975 when three frequency receivers in *its* possession were in use for *its* benefit, and three frequency receivers in possession of others were used for *their* benefit. Thus, the Government should be no less liable to Decca for its acts during the entire period than a private infringer would be for either direct infringement or active inducement of infringement under 35 U.S.C. § 271(b), or even contributory infringement, 35 U.S.C. § 271(c). It would be absurd to conclude that the United States is less liable to a patent owner than a private citizen when a patent is infringed. *Leesona Corp.* v. *United States*, 198 USPQ 4, 14 (Trial Div., Ct. Cl. 1978).

VI. *Contributing To and Actively Inducing Infringement*

The evidence in the present case clearly establishes that the defendant, the United States, constructed the Omega transmitting stations with the intent and knowledge that the three frequency mode would be received and used, not only by the defendant, but also by others in such a way that defendant was the *fons et origo* of the infringement. It not only told the world how to infringe the patented system, but also provided the essential means by which such infringement could be accomplished. Thus, defendant actively induced third parties to become co-infringers in use of plaintiff's patent when it not only published the Omega System format but also provided the source of the signals to be processed by the receivers. Consequently, defendant's active inducement of infringement renders it liable as an infringer within the meaning of 35 U.S.C. § 271(b).

Contributory infringement is also found in the present case in that defendant's suppliers, collectively, contributed to the infringement by defendant by manufacturing and supplying to defendant station electronics and receivers, neither of which were staple articles of commerce, or suitable for substantial

noninfringing uses, thereby enabling defendant and others to use the infringing system. However, since plaintiff's sole remedy for the suppliers' contributory infringement is by suit against defendant in the Court of Claims, defendant, as the ultimate infringer, is also liable for the contributory infringement by its suppliers. Therefore, I hold that the United States is liable for contributory infringement by its suppliers within the meaning of 35 U.S.C. § 271(c).[8]

The evidence clearly establishes that three frequency "breadboard" receivers were available for use and were, in fact, in use at the time the United States commenced transmission of the infringing three frequencies from two stations (Trinidad and Forrestport). Thus, direct infringement by parties in possession of the proper receivers is clear inasmuch as defendant made it possible for them to utilize the patented system. (*See*, fn. 7, *supra*.)

Defendant's lack of an economic incentive does not exculpate it from a charge of actively inducing and contributing to the infringement. The fact is uncontroverted that defendant made possible the sale by its suppliers of a nonstaple article of commerce not capable of substantially noninfringing uses, with the intent that the signals transmitted by the station electronics and the signals received by the receivers be used in practicing the

[8] In *Rohm & Haas Co.* v. *Owens-Corning Fiberglass Corp.*, 196 USPQ 727 (N.D. Ala. 1977), the court held there was active inducement of infringement by defendant who promoted and sold certain materials, not only with knowledge, but also with recommendation that they could be used in such a way as to infringe the patented process. The patented process was used by defendant's *customers*, whereby direct infringement of the plaintiff's patents was ultimately committed. Nevertheless, the defendant was held liable as an infringer. 35 U.S.C. § 271(b).

Under the same set of facts defendant was also held to be a contributory infringer as a consequence of its sale to its customers of materials which defendant knew were not staple articles of commerce nor suitable for substantial noninfringing uses, but which were used by its customers in practicing the patented process. 35 U.S.C. § 271(c).

claimed invention (the patented system). It cannot be overemphasized that transmission of the three frequency signal format constitutes an essential part of plaintiff's patented system regardless of the number, location, or ownership of the receivers utilizing that format.

Since the United States is held to have been guilty of contributory infringement as of the date that transmissions emanated from not less than two stations, (*i.e.*, the date on which the exclusivity of plaintiff's patent rights throughout the world was unquestionably preempted by defendant), I hold that the date of taking is October 24, 1967. Authority for determining that the date of taking is the date on which the United States became a contributory infringer is found in the court's tacit approval of this trial judge's opinion in *Tektronix, Inc.* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, 198 USPQ 378 (1978) wherein the court stated that it was in substantial agreement with the trial judge's opinion. That opinion (the trial judge's) clearly stated the position that if all the defenses provided infringers under title 35, U.S.C. are available to the Government, as the Government contends, then the Government must suffer the consequences of the definitions of and criteria to be applied to contributory infringers as set forth in that title.[9]

Other cases have similarly held that an accused infringer who actively induces another to directly infringe is liable as an infringer. *Cathodic Protection Service* v. *American Smelting & Refining Co.*, 190 USPQ 254, 266 (S.D. Tex. 1975); *Ransburg Corp.* v. *Automatic Finishing Systems, Inc.*, 412 F. Supp. 1357, 1366, 192 USPQ 333, 341 (E.D. Penn. 1976). Thus, if the United States is guilty of actively inducing direct infringement and therefore liable as an infringer under 35 U.S.C. § 271 (b), then the date that the active inducement occurs is another

[9] Incorporation of the liability provisions of title 35 in the statutory liability section of title 28 by implication was also used by this trial judge in support of his conclusion in *Leesona* v. *United States*, 198 USPQ 4, 14 (Trial Div., Ct. Cl. 1978).

choice for the date of taking. In the case at hand, the date that the defendant was guilty of contributory infringement is the date that the defendant was also guilty of actively inducing infringement, *viz.*, October 24, 1967.

Active inducement means basically that one has caused or aided and abetted another to infringe the patent. Inducement under § 271(b), while requiring active or affirmative steps to be taken with knowledge of the likely infringing result, is otherwise as broad in scope as the range of actions by which one may cause, urge, encourage, or aid another to infringe. *Ingersoll-Rand Co.* v. *Rockwell International Corp.*, 420 F. Supp. 277, 193 USPQ 787 (S.D. Fla. 1976). Section 271(b) of title 35, United States Code, contemplates that the inducer must be an active participant in the line of conduct for which an actual infringer has been determined guilty. Thus, the inducer plays the role of an accessory before the fact. Furthermore, in order for active inducement of infringement, the inducer must intend that direct infringement ultimately result. *Burger Train Systems, Inc.* v. *Ballard*, 552 F.2d 1377, 194 USPQ 255 (10th Cir.), *cert. denied*, 434 U.S. 860 (1977). All of these conditions have been met in this case with respect to the acts of defendant.

Finally, it should be noted that the mere sale of *articles* cannot constitute direct infringement of a *method* claim since such conduct is not making, using, or selling the patented method within the scope of 35 U.S.C. § 271(a). But, if the ultimate users practice the claimed method by applying the article in accordance with the defendant's *directions*, then the *defendant* has *actively induced* infringement and is *liable as an infringer*. *Noll* v. *O. M. Scott & Sons, Co.*, 467 F.2d 295, 175 USPQ 392 (6th Cir. 1972), *cert. denied*, 411 U.S. 965 (1973).

The facts of this case clearly warrant a finding of active inducement of infringement by the United States. This is clearly established by the construction of the stations and the ultimate transmission of three frequencies by the United States, which acts led to the utilization of the patented system by acts of third

parties in possession of three frequency receivers. But for the transmission of the three frequency mode, the three frequency receivers would have no utility.

Additionally, it should be pointed out that while the United States did not obtain possession of production quantities of commercially-manufactured three frequency receivers until 1969, it did have in its possession by October 24, 1967, and actually used, three interconnected individual single frequency receivers to practice the patented invention. The evidence shows that the defendant assembled three single frequency receivers in such a way as to simulate the existence of a single three frequency receiver in order to practice the patented invention. Thus, under the theories of active inducement of infringement, contributory infringement, and direct infringement, the Government is guilty of infringement as of October 24, 1967. October 24, 1967, therefore, will be used as the date of taking, not only for determination of the value of plaintiff's rights which were taken, but also for determination of delay compensation.

VII. *Reasonable and Entire Compensation*

A. *Royalty*

There are several elements which may be taken into consideration in reaching a conclusion as to what constitutes reasonable and entire compensation for manufacture and use by or for the Government of an invention described in and covered by a United States Patent. At the outset, there are those cases in which the patent owner had established a royalty rate in arm's-length negotiation of *nonexclusive* licenses *prior* to the eminent domain taking of the patent right by the Government. *See Marconi Wireless Telegraph Co.* v. *United States*, 99 Ct. Cl. 1 (1942); *aff'd. in part*, 320 U.S. 1 (1943), (wherein royalty rates of 10 to 33-⅓ percent were established). In such cases, the courts have applied the "entire market value" to the *infringing devices* to arrive at a realistic base to which the freely negotiated

royalty rate is to be applied. Where the parties have negotiated a license, the base to which the royalty rate is to be applied is usually well defined. However, in eminent domain takings or private infringements, the determination of a proper base is left to the trier of the recovery phase of the case. As pointed out in the *Marconi* case, *supra*, at 47:

> It would make no difference in the ultimate compensation to plaintiff if the reasonable royalty were fixed at 5 percent of the selling price of the complete machine rather than 20 percent of one quarter of the sales price of the machine.

As an alternative to determining "such items as costs, profits, apportionments, expense, etc." and quibbling over the quantum of such items, the court said:

> If the plaintiff has already established a royalty by a license or licenses, he has himself fixed the average of his compensation, and *if this has been established prior to the infringement*, the task of the court then becomes easy. (Emphasis supplied.)

Even post-infringement acts of the patent owner may also be considered "provided there is no room for suspecting collusion and the circumstances of the contracts would seem to repel any doubt of their good faith and negative the question of whether they had been entered into for the precise purpose of establishing an excessive royalty."

By implication, this court has recognized, therefore, that "costs, profits, apportionments, expense, etc." may be taken into account where compensation for the infringement cannot be determined on the basis of *pre-infringement* negotiations. Apparently, Decca took such items into account when it reduced the 7.5 percent royalty rate under the pre-infringement Bendix license to 5 percent under the post-infringement license to ITT/NSI.

Finally, if the royalty rates specified in the Bendix or ITT/NSI licenses are relied upon, the court in the present case is

still confronted with an inexact computation of the "cost" of the Omega system to the Government. The system was not purchased *as a system*, nor were all of the components of the transmitters and receivers acquired by contract. The Government was its own "prime contractor," thereby absorbing (according to its own estimate) more then $10 million of "overhead" in its operating budget instead of paying it to a private prime contractor out of procurement funds.

B. *Saving to the Government*

It is possible, on the other hand, to ignore the established royalty rate and, in lieu thereof, award the patent owner a percentage of the saving to the infringer over the cost of the next-best available noninfringing mode. This is precisely what the court did in the *Marconi* case, *supra*, at 70. In so doing, the court was aware of the fact that the Government was not in a position to make a "profit" on its infringement as would a private infringer, but that the saving to the Government by use of the invention was a *measure* of the patent owner's damage.

The Loran-C System was and still is the only feasible alternative to the Omega System for worldwide navigational coverage. The frequency that Loran-C uses, however, is insufficient to penetrate past a few feet of sea water and, therefore, it is a euphemism to call Loran-C the next best alternative to Omega. The Omega System was considered by all to be a significant advance over the best available alternative systems. There were 27 Loran-C stations in existence in 1965. It would have required approximately 42 additional stations to provide 100 percent worldwide geographic coverage equivalent to the coverage provided by Omega. Each of the additional 42 stations would have cost approximately $6 million if built on land and, if to be constructed in the arctic, antarctic, or at sea, would have cost substantially more.[10] Thus, the total value of Loran-C, a

[10] This estimate does not take into account the inflation factor which, between 1965 and 1975, would have increased the actual cost far above the estimate made in 1965.

worldwide network of 69 stations (exclusive of receivers), would be over $400 million (in 1965 dollars). The Loran-C System is also more expensive to operate inasmuch as it is estimated that the operation costs of the Omega System is approximately $29.2 million dollars per year *less* than the operation costs of a Loran-C system having the same worldwide coverage. Additionally, the evidence establishes that Loran-C receivers are more expensive than the receivers required for successful operation of the Omega System. Defendant, itself, has estimated that for worldwide Loran-C coverage (100 percent geographic coverage), and a full complement of 1,500 military user equipments (receivers), the total cost of Loran-C would be about $640 million *more* than an Omega System with comparable coverage, with the same number of receivers.

The Court of Claims, in *Olsson* v. *United States*, 87 Ct. Cl. 642, 25 F. Supp. 495, 37 USPQ 767 (1938), awarded a successful plaintiff a judgment based on 25 percent of the savings and advantages which the United States obtained by reason of its infringing use of plaintiff's patent rights. The Court specifically noted that the patentee did not make or license others to make the invention, nor did the plaintiff have any facilities to sell the goods to the federal government. The full savings enjoyed by the United States by virtue of the infringement was not awarded to the plaintiff since, as the court pointed out, the plaintiff was relieved of the trouble, expense, and responsibility of manufacture and sale of the invention covered by the plaintiff's patent. Concluding that the 25 percent savings was adequate to compensate the plaintiff, the court held that the *United States* was entitled to claim the benefit of the large value of the savings in costs and other advantages by reason of its assumption of the care, trouble, risk, expense, and responsibility attending incorporation of the invention in suit into acceptable design and manufacture of the infringing items. To substantiate this view, the court stated that the patentee should be entitled to recover an amount which the United States would

probably have been willing to pay for a license to use the invention by reason of the utility and several advantages accruing to the United States by reason of the embodiment of the invention.

A few years later, in *Marconi Wireless Telegraph Co.* v. *United States*, 99 Ct. Cl. 1, 53 USPQ 246 (1942), *aff'd in part*, 320 U.S. 1 (1943), the Court of Claims recognized that the defendant could have obtained the same basic results at a higher cost by using a comparable noninfringing device. The court specifically noted that the defendant could be held liable for the entire sum saved due to the infringement, but, rather, held the defendant liable for only 65 percent of the saving due to the infringement. The holding was based on the court's assumption that if the parties had negotiated a license for use of the invention, the price agreed on would have been something less than the difference between the cost of using the infringing and noninfringing devices. *Id.* at 71, 53 USPQ 260. Thus, the court determined that the plaintiff in that case should recover 65 percent of the sum saved by defendant as a consequence of the infringement.

In *Shearer* v. *United States*, 101 Ct. Cl. 196, 60 USPQ 414, *appeal dismissed* and *cert. denied*, 323 U.S. 676 (1944), the court was again called upon to make a determination of reasonable and entire compensation due to the defendant's taking of the plaintiff's patent rights. The court based its award on a standard of comparison between the goods that the Government had been using most extensively during the accounting period and the goods conforming to the plaintiff's patent. The noninfringing, next-best alternative goods were, in fact, the next lowest in unit cost to the patented goods. The court calculated the net savings per unit realized from use of the patented invention and added thereto approximately 12 percent more to compensate plaintiff for the inherent advantages defendant obtained by use of the patented invention in lieu of the available noninfringing alternatives. The court then apportioned the saving and value of the invention and allowed

recovery of 20 percent of the amount thus computed. Thus, the court used the savings, plus the advantages to the defendant, as the basis upon which the United States, as defendant, was liable to the plaintiff for each infringing unit procured without license or lawful right thereto.

In the *Shearer* case, *supra*, the court held that that case came within the entire market value rule in which the saleability or utility of an *article* is primarily due to the improvement imparted to the *combination*. The court, therefore, rejected the defendant's argument of segregating the patented elements from the unpatented elements, since it was the view of the court that the gist of the invention was the entire cooperative combination, and not some special details of construction. So, too, in the present case. The defendant would have the court segregate those elements which, standing alone, are not specifically defined by the claims and exclude them from the computation of the value of the invention or the base upon which the saving is to be computed. At the very least, the entire market value rule is applicable to the station electronics and receivers involved in the infringement in this case.

Recently, in *Tights, Inc.* v. *Kayser-Roth*, 442 F. Supp. 159, (M.D.N.C. 1977), 196 USPQ 750, an award was made to plaintiff based on one-third of the savings to defendant. (Delay compensation was set at 6 percent per annum.)

C. *Loss of Profits*

The alternatives available in the present case are somewhat limited and complicated by the fact that Decca was damaged by loss of value of the '816 patent between the time the Government announced its intention in 1965 to implement the Omega system and commencement of actual *use* of the invention on October 24, 1967. In the interim, Decca reduced the royalty rate on its exclusive license from 7.5 percent to 5.0 percent and was not given an opportunity to serve as a prime contractor to establish the Omega system. It was even precluded from earning a profit on the manufacture of the transmission and receiv-

ing equipment for the Government prior to expiration of the patent, the Government having either manufactured or installed the equipment itself or contracted with others to do so.

Decca was in a helpless condition. It could not obtain injunctive relief to prevent the infringement and its market for its foreign patent rights was virtually foreclosed. Accordingly, the damage to Decca cannot be measured by the mere "cost" to defendant of the hardware for establishment and operation of the Omega stations and receivers. Decca's loss of profits, on the other hand, are too speculative to afford a sound base upon which to compute reasonable and entire compensation. Some value should, however, be attributed to the loss of value of their foreign patent rights even though the defendant is not directly liable for actual infringement of those rights in this suit. In any event, there is no evidence to establish the quantum or value of the foreign patent rights or the dollar value of damage thereto. It must be left, therefore, for inclusion as an intangible element in overall evaluation of damage to Decca' patent property rights in the United States.

VIII. *Determination of Basis for Recovery*

It would serve no useful purpose to go through a tedious exercise of a detailed accounting of defendant's actual expenditures up to July 22, 1975, only to have extensive arguments as to whether this or that should be included or excluded from the computation of the "cost" of the complete Omega system to the Government. Neither would it be practicable to compute Decca's conjectural loss of profits. In the final analysis, the total recovery will be resolved on a lump sum (jury verdict) basis, whether it be by applying an empirical royalty rate to an arguable "cost" base, computing a supposititious profit loss, or by awarding the plaintiff an arbitrary percentage of the defendant's saving as reasonable compensation (exclusive of delay compensation).

There is adequate precedent, as well as factual basis, in this case for using the saving to the Government as the fundamental basis for the award. In *Marconi, supra,* this court allowed recovery of 65 percent of the saving to the Government. In *Olsson, supra,* the court allowed 25 percent. In *Shearer, supra,* the court not only allowed 20 percent of the saving, but added thereto approximately 12 percent to compensate plaintiff for the intrinsic value of the invention.

Confronted with a choice of means to arrive at a figure which would adequately compensate Decca for *the infringement,* and which would, at the same time, be *not less than* a reasonable royalty (within the meaning of 35 U.S.C. § 285) for the use made of the invention by the infringer, it is concluded that the recovery should be based on a percentage of the saving to the Government, which determination will give some weight to the value of the invention which has been used, in its entirety, by the Government.

According to defendant's own estimates, implementation of the worldwide eight transmitter Omega system would result in a cost saving to defendant, alone, of $640 million over a ten-year period as compared with Loran-C, the best available non-infringing system. Prorated on an annual basis, the saving to defendant would be $64 million per year for the eight transmitter system. Half that figure ($32 million per year) would be reasonable to allocate to the four transmitter system. Applying that figure to the period from October 24, 1967 to July 22, 1975 (7 years, 9 months), the period during which the four transmitter system was in operation, the saving would amount to approximately $248 million. Applying to that figure a recovery factor of 20 percent (the lowest of the cited cases), Decca would be entitled to the sum of $49.6 million. This figure, however, is subject to further adjustment to take into account the fact that the figures upon which it is based were only educated estimates used to stimulate congressional interest in the funding and construction of the Omega system and were, no doubt, highly inflated. Therefore, it is believed to be proper to discount the

figure by 50 percent in order to take into account the inflated nature of the original figures upon which the $49.6 million is based, thus reducing the net amount to $24.8 million. Since Decca has indicated that its estimated lost profit amounts to $41.9 million, and if its suggested royalty rate of 15 percent applied to Decca's estimate of $178.9 million as defendant's cost would be $26.8 million as reasonable compensation, an award in the amount of $24.8 million reasonably approximates Decca's own lower estimate the value of the invention. The figure representing Decca's estimate of its lost profit is not only highly speculative, but also would provide an excessive recovery. Even the figure based on Decca's estimate of defendant's cost of establishing the system would overcompensate Decca for the infringement.

Defendant's suggested recovery of only $56,994.00 is so unrealistic that it has been ignored in arriving at the figure of $24.8 million. The latter figure, however, was reached by discounting defendant's own estimate of its savings resulting from the infringement. Defendant would be hard put to deny that it realized a saving of considerable magnitude in light of the record in this case.

Accordingly, it is held that Decca is entitled to judgment in the amount of $24.8 million, exclusive of delay compensation.

IX. *Delay Compensation*

The computation of delay compensation is relatively easy once the date or dates of taking have been established. In this case, due to the unique nature of the manner in which the defendant took the plaintiff's system, a single date stands out as the proper date of the first taking, that date having been determined to be October 24, 1967. The delay compensation rates for the quinquennium periods up to 1975 will be those established in *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978). In light of the affirmative showing on the part of plaintiff of a higher delay

compensation rate than that stated in *Pitcairn* for the quinquennium of 1971 to 1975, a rate of 8 percent will be applied for those years after 1975, up to and including the date of payment of the judgment.

The saving to defendant began to accrue with the initial taking on October 24, 1967 and, logically, did not reach the optimum until after the first year or two of operation of the system. The $24.8 million will be prorated as follows:

YEAR	*Prorated Base (Annual Increment in Millions)*	*Delay Compensation Rate*	*Delay Compensation*
10/24/67-12/31/67	1.0	6.5	$ 12,109
1/ 1/68-12/31/68	1.5	6.5	162,500
1/ 1/69-12/31/69	3.0	6.5	357,500
1/ 1/70-12/31/70	3.0	6.5	552,500
1/ 1/71-12/31/71	3.5	7.5	900,000
1/ 1/72-12/31/72	3.5	7.5	1,162,500
1/ 1/73-12/31/73	3.5	7.5	1,425,000
1/ 1/74-12/31/74	3.5	7.5	1,687, 500
1/ 1/75- 7/22/75	2.3	7.5	1,034,465
7/23/75-12/31/75	24.8	7.5	820,436
1/ 1/76- 3/31/79	24.8	8.0	6,441,205
		Total Delay Compensation (Up to and including March 31, 1979)	$14,555,715
		Total Basic Compensation	$24,800,000
		Total (Reasonable and Entire) Compensation (Up to and including March 31, 1979)	$39,355,715
		Further Delay Compensation (April 1, 1979 to date of payment of judgment)	$5,436/ per day

The delay compensation from October 24, 1967 to March 11, 1979, therefore, is $14,555,715, and the rate per day from April 1, 1979 to the date of payment of the judgment is to be computed at $5,436 per day.

Adding to the delay compensation to March 31, 1979, the basic compensation of $24.8 million, Decca is entitled to judgment in the sum of $39,355,715 to that date, plus further delay compensation at $5,436 per day from April 1, 1979 to the date of payment of the judgment.

X. *Conclusion*

It is concluded on the facts and law applicable in this case that judgment in the amount of $39,355,715 should be entered in favor of plaintiff, Decca, as reasonable and entire compensation for the manufacture and use by and for defendant of Decca's patented system, including delay compensation, to and including March 31, 1979, plus additional delay compensation to be computed at the rate of $5,436 per day from April 1, 1979, to the date of payment of the judgment.

FINDINGS OF FACT

23.[1] Pursuant to Rule 131(c), further proceedings were conducted to determine the amount of reasonable and entire compensation due plaintiff under 28 U.S.C. § 1498 (a) for the unauthorized manufacture or use by or for the Government of the subject matter of claims 1, 4, and 11 of United States Patent No. 2,844,816 entitled "Radio Navigation Systems" (hereinafter "the '816 patent") which issued on July 22, 1958 and expired on July 22, 1975. The claims were determined to be infringed by defendant in an earlier, separate liability proceeding. *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F.2d 1070, 191 USPQ 439 (1976).

24. The '816 patent relates to a hyperbolic radio-navigation system wherein transmitter systems at two or more locations each emit three harmonically-related signals which, when received by a system capable of analyzing the three frequencies received, determine the geographic position of the receiver.

25. Decca developed and recommended to defendant's agencies in 1954 (prior to defendant's taking of Decca's patent rights) a system which it called the DELRAC Navigation

[1] Findings 1-22 are part of the court's judgment reported in *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F.2d 1070, 191 U.S.P.Q. 439 (1976), and are incorporated herein by reference.

System. The salient feature of the DELRAC system was that it was a three frequency system (10.2 kiloHertz (kHz), 13.6 kHz and 11 ⅓ kHz) which would provide ambiguity resolution to a distance of ± 36 nautical miles (n.m.) in two stages of Lane identification. It was the first system capable of affording a continuous worldwide medium accuracy coverage and it is the only system which could be used effectively by submarines submerged to depths of more than a few feet.

26. The infringement is based on defendant's adoption, procurement, and use of a navigation system (which defendant called the "Omega" system) made up of a combination of very low three-frequency (VLF) transmitters and three-frequency receivers. Defendant's transmitters normally include an AN/FRM-30 Timing and Control Set (including four cesium beam standards), and AN/FRT-88 Transmitter Set, and an AN/FRQ-18(V) Tuning Set including a shielded, tunable helix coil and antenna. These are the principal components of the "station electronics." In addition, auxiliary items normally present at each station (not mentioned in the liability opinion) include shelters for equipment, housing for personnel, roadways, prime power equipment, backup power equipment and some other items of no consequence in this phase of the case.

27. Although from 1954 on, defendant had been aware of Decca's DELRAC system and its proposal thereof to defendant, defendant did not adopt the system or proposal at that time, but instead, over the next ten years or more, explored the possibility of employing various forms of noninfringing systems, including single and double frequency modes. None of those noninfringing systems, however, was ever completely developed by defendant to the point of permanent implementation.

28. Defendant ultimately designed the Omega system, to fulfill its desire for a worldwide, all-weather radionavigation system.

29. Prior to building and operating the Omega system, defendant had installed and operated LORAN-A and LORAN-

C systems to provide navigation and assistance in the coastal confluence regions of the United States as well as other areas. LORAN-A is a MF (medium frequency) hyperbolic radionavigation system. LORAN-C is an LF (low frequency) hyperbolic navigation system. LORAN-C has a greater range and accuracy than LORAN-A. Together these two systems provided coverage for most of the Northern Hemisphere prior to establishment of the Omega System. However, neither LORAN-A nor LORAN-C has the range necessary to provide cost-effective worldwide coverage.

30. The use of VLF signals in the 10-15 kHz region set aside for navigation allows the Omega system to provide cost-effective worldwide coverage with only a fraction of the number of stations which would be required to provide worldwide coverage with LORAN-A or LORAN-C.

31. In 1958, prior to the establishment of the Omega program and about the time the '816 patent was issued, the Naval Electronics Laboratory (NEL) was experimenting with a VLF hyperbolic navigation system called the RADUX system.

32. In about 1962-63 (about five years after the '816 patent issued), the Navy experimented with systems employing very low frequencies (VLF) from transmitters located in Balboa, Panama Canal Zone; Haiku, Hawaii, and Forrestport, New York. Subsequently, transmitters were also installed at Trinidad (in the Carribean) and Norway. All of the stations were used to test the concept of having a few geographically-dispersed transmitters cover a large portion of the world.

33. In 1963, defendant evolved a "Technical Development Plan" (TDP) for a two-frequency VLF system (10.2, 13.6 kHz), which system would provide continuous worldwide, all-weather navigation and could be used by submerged submarines. The TDP also called for development of a two-frequency receiver with automatic dead reckoning and coodinate conversion for use aboard aircraft. The TDP also contemplated conversion of the existing transmitters at Forrestport, New York, and Haiku, Hawaii, from single-frequency mode to two-frequency mode.

34. During the 1962-63 timeframe, a group of experts designated as the Omega Implementation Committee (OIC) was hired by the United States to develop a complete technical layout for implementation of the three-frequency Omega system. In June, 1964, the OIC released the first edition of its report which defined a worldwide system consisting of eight Omega stations with average separations of about 5,000 nautical miles. The report contemplated resolution of lane ambiguity by using VLF transmissions of 10.2, 13.6 and 12.75 kHz, as well as other frequencies. The report, in effect, cleared the way for implementation of the Omega system and virtually preempted Decca's patent position, not only in the United States, but throughout the world.

35. Prior to June 1, 1964, Decca had been actively trying to persuade potential users to adopt its DELRAC system as a worldwide navigation system. These efforts started as early as 1954 when plaintiff not only circulated its proposal to defendant's agencies but also, through representatives of the United Kindom (U.K.), proposed the DELRAC system to the International Commercial Aviation Organization (ICAO) at its meetings in 1954 and 1957. A description of the DELRAC system had also been published in Radio Aids to Civil Aviation (1960). However, as of June 1, 1964, Decca's potential market for its DELRAC system became reduced to defendant alone, as both the U.K. and ICAO ceased dealing with Decca with respect to building or operating the DELRAC or any other navigation system.

36. On June 1, 1965, a project was established by the Chief of Naval Materiel (referred to as a CNM-Designated Project) in which the Omega Project Office, (PM-9, later PME-119), was established, with overall responsibility for establishment and operation of the Omega system. Captain Mavis X. Polk was placed in charge of the project.

37. At the time of the establishment of the Omega system as a "CNM-Designated Project," Decca possessed sufficient

qualifications to bid on the construction and operation of the system as the prime contractor. Decca was then, and still is, a leading manufacturer of complete systems employing the teachings of the '816 patent. None of Decca's licensees was either licensed or equipped to construct or operate complete VLF systems in 1965 and prior to establishment of the Omega system, defendant had never constructed or operated one. By establishing Omega as a "CNM-Designated Project," defendant, in undertaking the role of "prime contractor" for the Omega project, preempted the field in building and operating a worldwide Omega/Delrac-type system.

38. Normally, for the purpose of policing its patent rights, Decca reserved to itself the role of prime contractor to build and/or operate navigation systems. It had already performed all of the necessary R&D and engineering of such systems; would have been willing to make the site selections for the transmitters; prepared to manufacture all of the electric and electronic components, including first order spares, and was capable of designing and procuring all of the station equipment including antennas, buildings, etc. Decca normally subcontracted (but supervised and was responsible for) all site preparations and station construction for installations for which it was the prime contractor. It installed, tuned and tested the system operation, instructed the customer's personnel, and performed initial start-up and "de-bugging" type operations. Certain items such as tower erection and building construction were normally subcontracted out, but plaintiff retained technical responsibility for them, included them in the total price of the system, and applied thereto the normal Decca general and accounting costs (G&A) and profit mark-ups. Decca, in fact, sold a Decca MK X system to defendant for use in defendant's AUTEC project in the Bahamas in the above-described manner, *i.e.*, as a complete "turn key" job. In the AUTEC sale, defendant's auditor inspected plaintiff's pricing methods including its G&A and profit mark-ups and did not disapprove them.

39. Defendant began letting contracts in July 1965 for the construction of four, three-frequency transmitting stations which were intended to have "Interim Operational Capability" (IOC). The four stations were to be located at Trinidad (V.I.), Haiku (Hawaii), Forrestport (New York), and Bratland (Norway). A partial valley span antenna and certain roads and World War II buildings already existed at Haiku, and there were already buildings, roads and a communications antenna at Forrestport, New York. Defendant, therefore, did not need to build those stations completely. Trinidad and Norway, however, had to be built virtually from the ground up. The contract for the Norway station was let on July 29, 1965. The Trinidad station required two contracts. No copies of one of the contracts could be found, but from the testimony it is concluded that it was let no later than August 1, 1965. The other contract for Trinidad was let on August 12, 1965. The IOC stations were intended for the eventual transmission of the full, infringing Omega format. Trinidad, the first of the IOC stations to transmit, had "essentially a real Omega capability," that is, it transmitted the full 10.2 kHz, 13.6 kHz and 11 ⅓ kHz format.

40. Feasibility of the concepts to be employed in the Omega system were tested in 1966-67 through the network of the four IOC stations (Forrestport, New York; Trinidad; Haiku, Hawaii, and Bratland, Norway). The Trinidad station had the capability of transmitting and actually transmitted a three frequency Omega format consisting of 10.2, 11 ⅓ and 13.6 kHz signals on a test basis in February 1966. The Norway station transmitted in three frequency mode in February 1967, and the Haiku station in May 1967.

41. Defendant began seeking bids for three frequency transmitter component design as a consequence of the successful tests in February 1966, and by June 1966 was soliciting bids for three frequency *receivers* from as many as 18 manufacturers. Captain Polk testified that six companies had made

bread-board *receivers* "in anticipation of the contract we [the United States] put out." Since defendant's three frequency receiver solicitation started in June 1966, the companies which built the "bread boards" must have done so well prior to June 1967. The use of those "bread boards," together with three frequency Omega format signals from Trinidad, was sufficient to accord operational capability to the patented method of Omega signal processing even though the signals were being transmitted from that one station only. Since the signals from additional stations are a mere duplication of those from any other station (but for the differences in phase due to differences in distance), signals from a single station can be compared to those of a stable oscillator simulating a second station to illustrate how the system will work. Therefore, the use of the "bread boards" prior to June 1967 was at least an experimental use for the United States in the 1966-67 period. By September 30, 1967, defendant was operating a bank of three single frequency receivers, which were set up to receive the Omega signals and, by manual operation, demonstrated the mode of operation of the patent in suit. This constituted an experimental use-type infringement.

42. In June 1967, the Secretary of the Navy requested that the four stations (Forrestport, Trinidad, Hawaii, and Norway) be declared operational and that the Navy be designated the Department of Defense (DOD) Executive Agent responsible for exploitation of the Omega system.

43. On October 24, 1967, the Secretary of Defense responded by authorizing the Navy to accord operational status to the four stations and to program funds for the Omega system through the fiscal year (FY) 1969. The Secretary of Defense emphasized the potential of navigation satellite systems and requested the Joint Chiefs of Staff (JCS) to take a further review of cost effectiveness of such navigation systems. However, a Program Change Decision was made on September 6, 1968, without waiting for the cost studies by JCS or the Department of Transportation (DOT). That decision provided for a permanant worldwide Omega system, and gave the Navy authority to

maintain the four-station Omega network and to construct four additional stations, subject to host countries agreeing to participate in the funding and operation of the additional stations.

44. Thus, on October 24, 1967, all four stations (Aldra, Norway; Haiku, Hawaii; Forrestport, New York and Trinidad) were declared operational. This meant that the Government guaranteed that these stations would transmit the Omega format for at least a year. At that time, although there were a number of operational single frequency receivers which could take advantage of the 10.2 kHz signals which were being transmitted from the four stations, there were no three frequency receivers in quantity production which could use the 10.2, 11 ⅓ and 13.6 kHz signals to resolve lane ambiguity. During that same time, however, the Navy contracted for delivery of 140 AN/SRN-12 single frequency (VLF) receivers to replace the LORAN-A (MF) receivers in some of its surface fleet in anticipation of the use of the VLF receivers in connection with the Omega system. The foregoing acts constituted contributory and active inducement of infringement, as well as manufacture for the United States. As of October 24, 1967 the "taking" was consummated. As of this date, cost savings began to accrue to defendant's benefit.

45. The eight permanent transmitting stations planned for the Omega system were to be located in North Dakota, Hawaii, Norway, Japan, Argentina, Liberia, LaReunion Island, and Australia. As of July 22, 1975 (the date of expiration of the '816 patent), construction of the stations at North Dakota, Hawaii, Norway and Japan had been completed, wherefore, infringement by those stations commenced prior to expiration of the '816 patent. Construction of the stations at Argentina, Liberia, and LaReunion was not completed as of that date. The latter three stations had not yet started to emit the three frequency Omega signals since the helix coils at those stations, although installed, had not been "tapped" (as of July 22, 1975) to permit emission of the signals as prescribed in the Omega format. Con-

struction had not yet begun on the Australian station as of July 22, 1975, although contracts had been let for all essential material for construction of the station and all station electronics for that station were in possession of defendant.

46. In the Omega system, as built and used by defendant, the infringing three frequency format is *always* transmitted (except when one or more of the three frequencies is temporarily off the air for maintenance). There is never an intentional period of transmission of a noninfringing format (*i.e.*, less than three frequency), and the three frequency format is described by defendant as a "frequency requirement for all Omega stations."

47. The station electronics for each permanent Omega station include, among other things:

1. Omega Timing & Control Set AN/FRN-30
2. Omega Tuner AN/FRQ-18(V)
3. Omega Transmitter AN/FRT-88
4. A helix coil wound at the station site
5. Antenna

It is the combination of the foregoing items which enables the stations to transmit signals in the three frequency Omega format.

48. Each of the Timing & Control Sets, AN/FRN-30, (item 1, finding of fact 47) consists of eight unit racks, plus associated accessories. Unit Racks 1-6 are located at the site of the Omega station and function to generate up to five VLF signals in a predetermined format and control their transmission. Unit Rack 7, also located at the station, is a Digital Data Processor-Recorder Group which displays the data for each separate VLF signal received by the monitor receiver. Unit 8 is a receiver unit which is located a short distance from the transmitter to monitor the VLF signals transmitted by the associated station, along with those from other stations in the system. The Timing & Control Set contains the cesium beam frequency standards used to maintain the Omega signal format. While four cesium beam standards are present in the Timing & Control Set, only three form a part of the voting circuit, the fourth being an in-place spare which is kept activated because cesium beams will deteriorate if they are not kept energized.

49. The Antenna Tuning Set, AN/FRQ-18(V), (item 2, finding of fact 47) sequentially applies the 10.2, 11 ⅓, and 13.6 kHz signals to the proper taps on the helix coil in order to sequentially fine tune the helix coil and the antenna for transmitting these frequencies. Each Tuning Set contains six variometers, each with its associated gearbox, transmissions, control box, vacuum relay, and relay driver. One variometer assembly is an in-place spare. Each of the others is used for fine-tuning the antenna to transmit the VLV signals (*e.g.*, 10.2, 11 ⅓, and 13.6). Only three of the six variometers are required to enable transmission of the 10.2, 11 ⅓, and 13.6 signals for the claimed combination.

50. Each transmitting Set, AN/FRT-88 (item 3, finding of fact 47), contains two identical transmitter groups. One is connected to receive an RFsignal from the Timing and Control Set, amplify it through a series of amplifiers, and pass it through a matched out-put via the helix coil to the antenna which radiates the signal. The other transmitting group is an in-place spare which is connected to a dummy load. The two may be manually switched to allow the spare transmitting group to function while the other transmitting group is out of service. The stations in Hawaii, New York, Trinidad and Norway did not and do not have a spare transmitter group.

51. A receiver capable of using the Omega signals to indicate position is needed to utilize the Omega system. Receivers are "initialized by use of the Omega format, but may thereafter be operated for a period of time without reliance on the Omega format or by continuing to use the three frequency Omega format. An advantage of the Omega system is that it allows the user to initialize the system with the multiple frequency (10.2, 11 ⅓, 13.6 kHz) mode and thereafter use either the three frequency or the single frequency (10.2 kHz) mode. Surface ships, for example, can satisfy their minimum navigation requirements by using a simple 10.3 kHz receiver, such as the AN/SRN-12, with the aid of strip charts and dead reckoning, if lane resolution of lanes greater than 8 miles is adequate.

52. The AN/SRN-12 receiver was approved for service use with the 10.2 kHz signal of the Omega system. The receiver can indicate position within an 8-mile lane, but cannot, by itself, resolve lane ambiguity. As of July 22, 1975, when the '816 patent expired, there were at least 450 AN/SRN-12 receivers already installed aboard Government surface craft. In addition, 40 Tracor single frequency receivers had been used by the Navy for navigation. Ships using a single frequency receiver, such as the AN/SRN-12, can take advantage of the 10.2 kHz signal of the extensive Omega world coverage *without* lane resolution or identification to the same extent that aircraft or submarines using a three frequency receiver can take advantage of the system *with* lane resolution and identification, the range of coverage of the system not being related to the *number* of frequencies used.

53. The AN/ARN-99 (XN-1) receiver was the first automatic, quantity-produced three frequency Omega receiver approved for Navy operations. (This was the forerunner of the AN/ARN-99 three-frequency receiver.) The AN/ARN-99 (XN-D) was first installed and tested in an aircraft in June 1969. Subsequently, the AN/BRN-7 three-frequency receiver was developed for use in submarines by modifying the software in the ARN-99 to facilitate lane resolution while submerged.

The processing of the Omega signals in AN/ARN—99(V)1, ARN-99, and BRN-7 receivers is controlled by computer software. The AN/ARN-99(V)1 normally shares the use of a general purpose computer, used with other equipment aboard the craft or vessel, whereas the ARN-99 and BRN-7 receivers are provided with their own built-in computer.

ARN-99 and BRN-7 Omega receivers use a propagation model developed by Naval Electronics Laboratory and, thereby, are able to apply propagation corrections to incoming signals. They also select the optimum orientation of the loop antenna; compensate for the motion of the craft or vessel; compensate for the oblateness of the earth, and are able to provide a direct readout of position in terms of latitude and longitude.

54. Decca lost a potential profit by virtue of defendant's preemption of Omega. That profit would have been at at least equal to the profit Decca would have made on a "turn key" sale of such a system to defendant. Taking first the system as it actually existed at the end of FY 1975, including relevant receivers, and using Decca's pricing methods and markups employed in the sale of its MK X systems, Decca estimates the total price of the system would have been about $129.7 million, of which Decca figures its profit would have been about $22 million. This figure does not take into consideration the facts that (a) the Decca MK X system was being sold in a competitive market, (b) defendant had an urgent military need for Omega, (c) Omega is unique; it is the only system which can reach submerged submarines, and (d) Omega presents a tremendous saving ($640 million) compared to the next best noninfringing alternative. Had those facts been taken into consideration, Decca estimates a lost profit of about $32 million.

55. Defendant's cost saving over a 10-year period, compared to the next best noninfringing system, LORAN-C, was expected to be approximately $640 million, according to defendant's own computations and representations. (See Appendix A) Since Decca was both willing and able to build and operate the Omega system, had contributed materially to the relevant technology, and had demonstrated the feasibility of the system, an award of a magnitude such as the 20 percent of saving awarded in *Shearer* v. *United States*, 101 Ct. Cl. 96, 60 USPQ 414 (1944), or the 25 percent of the saving awarded in *Olsson* v. *United States*, 87 Ct. Cl. 642, 37 USPQ 767 (1938), would be justified. If the saving is amortized on the basis of $64 million per year for an eight transmitter system, or $32 million per year for a four transmitter system, 20 percent of that amount would be $6.4 million. Computing the saving from October 24, 1967 to July 22, 1975, the recovery would be approximately $49.6 million. Assuming further that the savings estimate was inflated by a 100 percent markup, discounting the $49.6 million per year figure by 50 percent leaves a realistic saving of $28.4 million over the October 24, 1967 to July 22, 1975 time period.

56. If the willing licensor-willing licensee approach is employed, the entire market value rule should be used in determining the base upon which a reasonable royalty should be computed. Due to the fact that defendant itself made the infringing system, defendant's out-of-pocket expenditures do not fairly represent the full market value of the system since it does not include normal G&A expense or a profit markup which would ordinarily be included in a full market value price. Therefore, many items beyond defendant's direct procurements must be included in arriving at the entire market value of the system and use thereof.

57. Based on Decca's calculations, including its projected profit and general and administrative expense, the total cost of an eight-transmitter system would be:

Prime Contractor role	$15,000,000
RDT&E	48,500,000
Sta Ops (O&M,N)	30,300,000
Installation	4,000,000
Construction	43,700,000
Electronics	11,900,000
Receivers	25,500,000
Total	$178,900,000

58. The royalty rates of Decca's prior licenses are not applicable to the system construction phases of the case at bar. Decca did not license system construction, and its licensees were not equipped to construct systems. In addition, prior to defendant's taking, no licenses were granted even for the components of Omega/Delrac-type systems. After defendant's taking, one license was granted to ITT for Omega/Delrac-type system components, but since defendant's taking was already in full progress, the rates of that license cannot be taken as a controlling expression of the full value for the present determination, even for components.

59. If compensation is to be based on a reasonable royalty applied to the full market value of the system as it existed from

October 24, 1967 to July 22, 1975, a royalty rate of 10 percent is adequate for the case at bar. This takes into account the importance of the patent in suit, the uniqueness of the Omega system which was made practical by its use of the patent in suit, and the vast cost saving ($640 million) as compared to the next best noninfringing alternative, LORAN-C.

60. Using a rate of 10 percent, and if Decca's proposed base of $178.9 million is used, a royalty of $17.89 million is found.

61. The figure of $17.89 million for a license is below the above-stated $22 million lost profit figure estimated by Decca for the sale of a complete system.

62. Although the figure of $17.89 million may be a reasonable royalty for defendant's *procurements*, the value to plaintiff of what was taken was substantially more than the mere value of a license covering those items.

63. Plaintiff did not grant licenses for complete systems under the patent in suit. Plaintiff licensed components, but habitually controlled the installation and operation of the entire system. Therefore, there is no controlling precedent for plaintiff's licensing the patent in suit for the sale of complete systems, and there is no controlling precedent prior to defendant's "taking" for licensing even the electronic components for the Delrac/Omega invention.

64. In the case at bar, defendant's saving by virtue of building the infringing system instead of the next-best noninfringing alternative, *i.e.*, LORAN-C, was unusually large (*i.e.*, $640 million), and at the same time defendant obtained thereby a system that could be used by continuously submerged submarines. By the precedent of *Marconi Wireless Telegraph Co.* v. *United States*, 99 Ct. Cl. 1, *aff'd in part and rev'd in part*, 320 U.S. 1 (1943), *Olsson*, *supra*, and *Shearer*, *supra*, Decca, in arm's-length negotiations could have justifiably bargained for a higher payment than the mere $17.89 million arrived at by the licensing approach based solely on the basis of cost saving.

65. Taking all of the above facts in summation, neither the "lost profits" basis, nor "royalty-licensing" approach of *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978), and *Tektronix* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, 198 USPQ 378 (1978), fits the case at bar as well as the "savings to defendant" approach and, accordingly, a total basic award of approximately half of $49.6 million recovery figure as outlined above, namely $24.8 million, would constitute the basic reasonable and entire compensation for defendant's manufacture and use of Decca's patented system, exclusive of delay compensation.

66. Eight Timing and Control Sets, AN/FRN-30, (item 1, finding of fact 47) were produced by the Naval Electronics Systems Command (NAVELEX) for the eight permanent Omega stations under contract N00039-70-C-0533 (hereinafter " '0533 contract") with the Litcom Division of Litton Systems, Inc. The final cost of these sets, exclusive of spare parts and cesium beam standards, was $2,158,341 or $269,793 each. In addition, a ninth timing and control set was procured under A00010 of that contract. The cost of this ninth timing and control set, exclusive of marking and packaging, is $212,738.68. The total for this item, therefore, is $2,371,079.60.

The following is a tabulation by contract line item of the amounts obligated for each item ordered under the '0533 contract:

Item	*Description*	*Quantity*	*Total Extended Price*
0001	Omega Time & Control Set	8	$2,158,341.00
0001AA	Manuscript Submittal	lot	313,726.00
0002	Interim Repair Parts		
	Exhibit A	lot	279,418.26
	Exhibit B	lot	2,380.32
	Exhibit C	lot	16,662.24
0003	Maintenance Repair Parts		
	Exhibit B	lot	123,081.74
	Exhibit C	lot	215,412.68
0004	Data		Not separately priced

Item	*Description*	*Quantity*	*Total Extended Price*
0005	Instruction Manual	15 Sets	$ 24,300.00
0006	Conduct Course	2 courses	4,280.00
0007	Foreign Technical Services	44 mandays	1,412.50
0008	Technical Services Spares List B	31 mandays	6,082.37
0009	Support for items 6, 7, and 8	Est.	6,153.15
Contract Value			$3,151,250.26

67. The cesium beam standars used as components of the AN/FRN-30 timing and Control Set (item 1, finding of fact 47) to control the transmission cycle were separately procured from Hewlett-Packarad Company under contract N00060-70-C-0688, at a cost of $12,655.59 each. Twenty standards are sufficient for five of the eight permanent stations. The cesium beams for the remaining three would be taken from the four earlier established stations (Trinidad, Forrestport, Hawaii, and Norway).

68. Eight Omega Antenna Tuning Sets, AN/FRQ-18(V) (item 2, finding of fact 47) were procured under NAVELEX Contract N00039-71-C-0012 (hereinafter " '0012 contract) with Continental Electronics Manufacturing Company. The cost of the eight AN/FRQ18(V) tuning sets, along with the frames and Litz wire for the associated helix coils, exclusive of repair or spare parts, comes to a total of $2,928,848.60, or $366,106 each.

The following is a complete tabulation by contract line items of the amounts obligated for each item ordered under the '0012 contract:

Item	*Description*	*Quantity*	*Total Extended Price*
1	Omega Tuning Set, two reels of Litz wire, 960 Litz cable pads	4	$1,653,533.32
2	Omega Tuning Set, one reel of Litz cable, 576 Litz cable pads	4	1,275,315.28

Item	*Description*	*Quantity*	*Total Extended Price*
2A	Transportation Charge	lot	$ 1,380.00
3	Material Sample	1	No charge
4	Special Tools	8 sets	No charge
5	Interim Repair Parts Spares List A	8 sets	369,284.40
6	Interim Repair Parts,	1 set	73,983.00
7	Data Items		Not separately priced
8	Interim Repair Parts, List A005	8 sets	86,717.52
9	Maintenance Repair Parts, List A002	1 lot	130,418.48
10	Technical Services Domestic	150 mandays	24,600.00
11	Support at actual cost	Est.	70,453.00
12	Technical Services Foreign	45 mandays	8,640.00
13	Support at actual cost	Est.	28,300.00
14	Repack MILVAN	1 job	29,350.00
Contract Value			$3,875,979.00

69. Eight Omega Transmitter Sets, AN/FRT-88 (item 3, finding of fact 47), were procured under NAVELEX contract N00039-69-C-0560 (hereinafter " '0560 contract") with Litcom Division of Litton Industries, Inc. These eight sets, each containing two transmitter groups, were procured at a cost of $2,413,878 or $301,735 each.

The following is a tabulation by contract line item of the amounts obligated for each item ordered under the '0560 contract:

Item	*Description*	*Quantity*	*Unit Price*	*Total Price*
1	VLF Omega Transmitter AN/FRN-88	6 sets	$296,999.67	$1,781,998.00
2	Equipment Repair Parts 1 & 10	6 sets		
	Exhibit A		214,500.00	313,552.00
	Exhibit B		69,000.00	
	Exhibit C		30,052.00	
3	Maintenance	1 lot		
	Repair Parts Items 1 & 10 Exhibit D		$195,994.00	$195,944.00

Item	*Description*	*Quantity*	*Unit Price*	*Total Price*
4	Data Items	(included in Item 1)		Not separately priced
5AA	Prepare and Furnish Instruction Material			11,748.00
AB	Conduct Course	10 mandays	$	$ 2,090.00
AC	Travel & Subsistence for AB			1,564.62
6	Deleted			
7	Deleted			
8	Services—Domestic			6,451.00
9	Subsistence & Travel			6,700.00
10	VLF Omega Transmitter AN/FRN-88	2 sets	315,940.00	631,880.00
11	Equipment Repair Parts, Item 10			63,207.00
Contract Value				$3,015,134.00

70. The procurement of each Omega station includes Government-Furnished Equipment (GFE) costing $11,500 and consists of: two AN/USM-281A oscilloscopes ($2,000 each), two Model 1123-9811 G.R. digital synchrometers ($1,500 each), and three Model 16 Minneapolis-Honeywell recorders ($1,500 each).

According to defendant's calculations of the total cost of each station, the estimated cost of the in-place spares, such as one of the four cesium beams; one transmitter group; one variometer assembly, and two oscilloscopes which were mounted in place so employees would not remove them from the station, is $269,159. The cost of adding components for generating and transmitting FT_1 and FT_2 was estimated as $108,279. The estimated per station cost of the monitor receiver and display equipment in racks 7 and 8 of the AN/FRN-30 was $54,752. These items (totaling $432,190), however, are not excludable from the computation of the cost of the necessary station electronics for Omega transmission.

71. Six of the permanent Omega stations use or will use a top-loaded monopole antenna similar to the antenna at the station located at LaMoure, North Dakota. The stations at Nor-

way and Hawaii use a valley-span antenna. The top-loaded monopole is a common type of antenna and the valley-span is an acceptable alternative, although less common. Each antenna was individually designed for its particular location and would not have been installed nor would use thereof be continued except to sustain the Omega system. The VLF communications stations in the Omega System utilize antennae tuned by helix coils, as well as transmitters to amplify and apply signals to the helix coils. The helix coils and amplifiers, therefore, are essential components of the system covered by the claimed combination. Hence, their market value is dependent upon use of the invention claimed in the patent in suit.

72. While the Omega system transmits three Omega frequencies, most military Omega navigation receivers utilize only the 10.2 kHz signal for operational purposes after initialization by use of the three frequency mode. Use of those receivers, in combination with Omega transmitters, constitutes infringement of the claims of '816 in suit since they have no utility unless they are initialized by use of the Omega system, *i.e.*, they receive and utilize the Omega frequency format transmitted from the Omega stations.

Mr. Fletcher, an electronics engineer, who had been involved with Omega since October 1965, estimated the cost of the station electronics for a station generating and radiating a 10.2 kHz signal, alone, at $522,466. He estimated the cost of adding the 11 ⅓ and 13.6 kHz signals used for initialization and lane resolution in ARN/-99 and BRN-7 receivers as $108,279 per station. His calculations were based, however, on estimates rather than actual procurement costs.

73. The cost of designing and constructing complete Omega *stations* includes the cost of items such as land, buildings for equipment, personnel, roads, prime power equipment, and diesel backup generators. The named items, however, are not part of the claimed invention of '816, nor are they items which must be specially created to utilize the '816 invention. The

building used to house the helix, however, is specially designed and constructed for use in the infringing system. Accordingly, that part of the cost of designing and constructing the Omega stations attributable to design and construction of land, buildings for equipment (except the helix building) and personnel, road, prime power equipment, and diesel backup generators are excluded from computation of the base.

74. Plaintiff, through its American subsidiary, Decca Navigation Systems, Inc., by an agreement dated November 9, 1961, licensed Bendix Corporation to manufacture and sell transmitters and receivers for use in connection with plaintiff's *Decca Navigator Systems* and *Dectra Systems*. Plaintiff handled the problem of ancillary equipment and expenses involved in the construction of stations in which the transmitters would be installed by incorporating within the Bendix license the following definition of transmitters:

> 'Transmitter' shall mean all of the technical equipment used in the production of satisfactory and reliable Decca or Dectra service from, but not including, the primary power supply to, and including, the dispatch of the service, but shall not include land, building[s], vehicles, diesels, real property improvements and the primary power supply.

Defendant's expert witnesses summarized the cost of design and construction of Omega stations and apportioned it in accordance with this definition of transmitter.

In making these apportionments, items such as administration or supervision were treated by defendant as overhead, since they were applicable to all tasks, and were apportioned to the "transmitter" and "non-transmitter" or other categories in proportion to their dollar values.

75. It was estimated by witnesses that the cost of designing the antennas for the permanent Omega stations was between $150,000 to $200,000 for the architectural portion and $50,000 to $100,000 for the electrical portion per station. Thus, total

antenna design costs ranged between $200,000 and $300,000 for all eight stations.

76. The Omega station at LaMoure, North Dakota was first declared operational on October 1, 1972, a little less than 3 years prior to expiration of the '816 patent. A three frequency Omega format consisting of 10.2, 11 ⅓, and 13.6 kHz signals was radiated from the LaMoure station at all times when the station was in operation.

77. The parties stipulated that the following expenses reflect the cost of installing station electronics and interconnecting them to the antenna in the North Dakota station:

ITEM[2]	COST
ON-SITE INSTALLATION	
Engineering	$ 43,300
Mechanics	137,000
Contract	9,200
MISCELLANEOUS SUPPORT	
Management & Supply	23,500
Engineering & Drafting	86,100
Technical Support	23,600
MATERIALS	84,600
TOTAL	$407,300

The cost of station electronics for permanent stations is at least $1,275,165 per station. With the addition of the installation costs, the total cost of the North Dakota station is $1,682,465. This figure includes the cost of installed station electronics capable of radiating only a 10.2 kHz signal.

78. The following figures represent defendant's computation of the cost of the North Dakota station as modified to operate in the Omega format:

[2] All labor charges have been increased by approximately 30 percent to take into account leave and fringe benefits. Items include travel and per diem expenses where incurred.

Item	*Cost of Installation*	*Cost of Components*	*Total Cost As Installed*
Basic 10.2 kHz	$330,127.30	$522,466	$ 852,593
11 ⅓ and 13.6 add-on	19,569.64	108,279	127,849
Subtotal	$349,696.94	$630,745	$ 980,442
FT_1 and FT_2 add-on	19,569.64	108,279	127,849
Subtotal	$369,266.58	$ 739,024	$1,108,291
Spares add-on	$ 35,739.33	$ 269,159	$ 304,898
Subtotal	$405,005.91	$1,008,183	$1,413,189
Monitor add-on	2,294.09	53,252	55,546
TOTAL	$407,300.00	$1,061,435	$1,468,735

79. The costs of design and construction of the North Dakota station, *if* apportioned in accordance with a reasonable interpretation of the definition of transmitter appearing in the Bendix license are as follows:

ITEM	COST
Construction	
Transmitter[3]	$2,991,939
All other Costs:	
Helix Building	336,822
Transmitter Building	464,008
General Purpose Building	515,262
Site Work (roads, utilities, minor structures, etc.)	977,425
In-House and other procurement	16,496
Supervisory, Inspection & Overhead (SIOH)	142,351
TOTAL	$5,444,303

[3] Includes an apportioned amount of SIOH and $186,100 for the total cost of procurement and installation of electronic shielding in the helix building. In addition, transmitter includes the antenna, and associated structure as set forth in DA 28.

ITEM	COST
DESIGN[4]	
Transmitter	$283,668
All other Costs	399,225
TOTAL	$682,923

Combining the apportioned figures relating solely to the transmitter construction *and* design results in a total cost for the construction and design of just the "transmitter" portion of the station (including antenna) of $3,275,607. ($2,991,939 (construction) plus $283,668 (design)).

80. The Haiku, Hawaii station is located in a former World War II communications station. In 1962, the Haiku station was operated with a station in Balboa using a master-slave transmission mode rather than the cesium beam synchronization used in Omega. At that time, it was a Naval communications facility and was used in early Omega research for communications. The station at that time contained an FRA-31 transmitter (having only one transmitter group). The FRA-31 was the antecedent of the FRT-88 transmitter installed in the permanent Omega stations.

The original Hawaii station was modified for three-frequency capability in May 1967, and was further modified in June 1967. Transmission in the three frequency mode from the original station was suspended on February 15, 1973.

81. Construction of a permanent Omega station at Hawaii began in November 1972 and continued until May 1974.[5] The station checkout began in June 1974.

From June through September 1974, the permanent station radiated test transmissions which were of low power. Damage to the antenna during a heat and corona test at 9.8 kHz, on June 17, 1974 delayed radiation of higher power transmissions. Accordingly, shortening of the helix coil for the permanent station

[4] DA 40 contains a line marked "Other transmitter" which denotes expenses which are allocable to transmitter designs which were not used in the station configuration or services that were incurred after the station became operational.

to enable tuning at 10.2 kHz was not accomplished until July 2, 1974. The station transmitted intermittently throughout the period from June 1974 through January 1975, when it resumed transmission at reduced power. The Hawaii station was declared fully operational in the three frequency mode in January 1975, approximately 6 months prior to expiration of the '816 patent.

82. The parties stipulated that the following expenses reflect the cost of installing station electronics in the permanent Hawaii station:

ITEM[5]	COST
ON-SITE INSTALLATION	
Engineering	$ 36,700
Mechanics	167,700
Contract	66,000
MISCELLANEOUS SUPPORT	
Management & Supply	53,400
Engineering & Drafting	63,800
Technical Support	54,300
MATERIALS	68,000
TOTAL	$509,900

83. Combining the cost of installation with the cost of station electronics for permanent stations, which is $1,275,164.58, results in a total cost of $1,785,064.58 for the station electronics as installed in Hawaii.

84. The costs of design and construction of the Hawaii station, if apportioned in accordance with a reasonable interpretation of the Bendix license, are as follows:

[5] Labor increased by approximately 30 percent for leave and fringe benefits. Items include travel and per diem expenses where incurred.

ITEM	COST
CONSTRUCTION	
TRANSMITTER[6]	$3,234,310
All Other Costs	
Helix Building	$ 301,960
Transmitter Building	407,546
Site Work (roads, utilities, minor structures)	223,682
In-house and other procurement	9,335
Supervisory, Inspection & Overhead (SIOH)	58,850
TOTAL	$4,235,693
DESIGN	
Transmitter	361,446
All Other Costs	140,534
TOTAL	$ 501,980

85. Thus, the cost of design and construction of only the "transmitter" portion of the Hawaii station including the antenna was approximately $3,595,756 ($3,234,310 for construction, $361,446 for design).

86. During the course of implementing the Omega system, a small experimental VLF station was established at Novik, Norway, in 1965. A permanent Omega station was established, however, at Aldra (near Bratland), Norway. The Novik installation was established to determine the feasibility of a valley-span antenna. Omega signals were never satisfactorily radiated from that installation. The station at Aldra, installed in March 1966, consisted of an FRA-31 transmitter, timing and tuning equipment, and a helix coil, all mounted on flatbed trailers. The helix coil was originally housed in an inflatable dome, and later in a rigid structure, neither of which contained shielding. The station was modified for three frequency

[6] Includes apportioned part of SIOH and the $177,880 estimated cost of shielding for the helix building.

capability in May 1967. However, because of a fire in the helix house in the fall of 1970, the Aldra station lost its capability to transmit the 11 ⅓ kHz signal for a time. From that time until August 1973, only 10.2 and 13.6 kHz signals were radiated from the station. The station discontinued transmission until the permanent station was declared operational again on December 20, 1973.

87. The antenna used at Aldra was, at all times, a valley-span antenna with two spans extended from Bratland, across a fiord, to an off-shore island. The spans thus formed a V-shape with the common point being the island. The spans were constructed prior to May 1967 when modification of the station for three frequency capability was completed.

88. The parties stipulated that the following expenses reflect the cost of installing station electronics in the permanent Norway station:

ITEM[7]	COST
ON-SITE INSTALLATION	
Engineering	$ 37,900
Mechanics	49,200
Contract	0
MISCELLANEOUS SUPPORT	
Management & Supply	51,600
Engineering & Drafting	40,100
Technical Support	14,300
MATERIALS	76,800
TOTAL	$269,900

89. Combining the cost of installation with the cost of permanent station electronics, which is $1,275,164.68, results in a total cost of $1,545,064.58 for installed station electronics.

90. The costs of design and construction for the permanent Norway station, apportioned in accordance with a reasonable interpretation of the Bendix license, are as follows:

[7] Labor increased by approximately 30 percent for leave and fringe benefits. Items include travel and per diem expenses where incurred.

ITEM	COST
CONSTRUCTION	
Transmitter[8]	$1,913,214
All Other Costs:	
Helix Building	152,577
Transmitter Building	335,963
Site Work (roads, utilities, minor structures)	604,427
In-house and other procurement	6,748
Supervision, Inspection & Overhead (SIOH)	64,741
TOTAL	$3,077,670
DESIGN	
Transmitter	232,770
All Other Costs	91,447
TOTAL	$ 324,217

Thus, the total cost of design and construction of the "transmitter" portion of the station (including the antenna) is $2,145,984 ($1,913,214 for construction, $232,770 for design).

Adding to this the installed cost of all station electronics at the Norway station ($1,545,064.58) results in a total cost of $3,691,048.58, exclusive of the installed costs for FT_1 and FT_2 capability, in-place spares, and monitor.

91. The station at Japan is located at Tsushima. It is generally similar to the station at LaMoure, North Dakota.

92. Installation of the Transmitter and Timing & Control equipment at the Japanese station commenced in April 1973. Installation and site construction continued until mid-December 1974 when the station checkout commenced. The station was unable to radiate useable 10.2, 11 ⅓, and 13.6 kHz signals until after the power tests were concluded and the helix coil shortened to tune the antenna for 10.2 kHz transmissions. The station com-

[8] Includes an apportioned amount of SIOH and $172,596 for the total cost of shielding for helix building.

menced transmission under low power tests at 9.8 kHz at the end of February 1975, and was declared fully operational on April 30, 1975, a few months prior to expiration of the '816 patent.

93. Japan stood to benefit from the construction of the Omega station and use of the Omega system, and agreed to bear a large portion of the costs of the station in Japan. The agreement with the Government of Japan required the United States to supply the station electronics for the station, but provided that the Japanese Government would construct, operate, and maintain the station. The cost to the United States of installing the station electronics in the Japanese station was $113,200. In addition, the United States provided the entrance bushing for the helix house at a cost of $10,940; performed design services related to the Japanese station having a value of $75,600.83; provided for installation and contributed to the cost of materials in the amount of $36,600; and provided engineering, management, drafting and technical support services at a cost of $76,600. The total cost of the contribution by the United States to the design, fabrication, construction, and electronics installation at the Omega station at Tsushima, Japan, was:

ITEM	COST
Station Electronics	$1,275,164.58
Installation	113,200.00
Entrance Bushing	10,940.00
Design and Engineering	75,601.00
Installation Materials	36,600.00
Technical Support	76,600.00
TOTAL	$1,588,105.58

94. The Omega stations at Argentina, Liberia, and La-Reunion were not operational in time to transmit Omega signals prior to expiration of the '816 patent on July 22, 1975. As of that date, the helix coils, although installed, had not been tapped at any of these stations. Otherwise, they were capable of operation in the three frequency mode.

95. The tapping of the helix coil for the Argentina station began on August 26, 1977, and the station was not finally tested until September 19, 1977. As of July 22, 1975, the resonant frequency and static capacity of the antenna at Liberia had not been finally measured, nor had the helix taps been calculated, or made. At the LaReunion station, the erection crane was still attached to the tower, the helix frame was erected but no wire had been wound on the frame, the helix tap locations had been calculated and the plate transformer for one of the transmitters was still in transit to the site as of July 22, 1975.

96. The necessary station electronics for the Omega stations at Argentina, Liberia, and LaReunion, although available for use in combination with ARN-99 and BRN-7 receivers prior to the expiration of '816, were not operational by that date.

97. Although all of the station electronics for the Australia station were under procurement or delivered to defendant prior to July 22, 1975, funds for construction of the Australia station were not available until July 1, 1975, since they were not provided until the FY 1976 budget. Thus, the Omega station was not operational in the three frequency mode during the term of the '816 patent.

98. The station electronics used at the so-called "interim stations" at Hawaii, Forrestport, Trinidad, and Norway, before being declared fully operational, differed only slightly from the station electronics used or planned to be used in the permanent, fully-operational Omega stations. The Hawaii, Trinidad, and Forrestport stations originally used an AN/FRA-31 transmitter, rather than the AN/FRT-88 transmitter. This transmitter contained only one transmitter group and, thus, no in-place spare transmitter groups were used at the stations equipped with the AN/FRA-31 transmitters. Up to the present time, the Trinidad station was only one transmitter group with no in-place spare. The transmitter originally used at the Norway station was built by Naval Electronics Laboratory (NEL). Hence, the market value of that transmitter is difficult, if not impossible, to ascertain.

99. The parties stipulated, however, that the costs of designing, developing, fabricating, and installing station electronics at the stations at Hawaii, Forrestport, Trinidad, and Norway, prior to installation and operation of the Omega system (stations radiating only a 10.2 kHz signal and the additional cost for 11 ⅓ and 13.6 kHz signals), were:

	Hawaii	*Forrestport*	*Trinidad*	*Norway*
Cost of basic 10.2 kHz station	$488,901	$546,751	$585,256	$496,540
Cost of adding 11 ⅓, 13.6 kHz	73,400	73,400	73,400	73,400
TOTAL	$562,301	$620,151	$658,656	$569,940
GRAND TOTAL	$2,411,048			

The above figures include charges for machine shop support, installation, travel and per diem, freight, and design and development in the following amounts:

	Hawaii	*Forrestport*	*Trinidad*	*Norway*
Support Services (labor/overhead)	$10,000	$10,000	$11,000	$13,500
Installation	9,850	9,850	12,100	7,950
Travel & per Diem	5,550	6,350	9,650	9,850
Freight & Shipping	1,800	5,200	3,000	10,000
Engineering Mft., Design & Development	52,200	52,200	52,200	52,200

100. The Trinidad "interim station" was located at the site of a World War II LF communications station. It was employed as a replacement for the single frequency at Balboa, Panama Canal Zone (which was a communications station the Omega project had been allowed to use for research). Construction to renovate the Trinidad station so that it would be useable in the Omega project began in late 1965 and was completed in February 1966.[9]

[9] While the exact site for the permanent Trinidad station had not been selected until 1965, planning for interim stations, such as Trinidad, began in 1963.

When installation was completed and the station became fully operational on February 16, 1966, the Trinidad station transmitted a three frequency (10.2, 11 ⅓, and 13.6 kHz) format. It was also capable of broadcasting just 10.2 and 13.6 kHz signals, if desired, when it became fully operational by February 16, 1966.

101. The original LF communications equipment at Trinidad included two valley-spans forming a valley-span antenna, and buildings for sheltering a transmitter and helix. The total cost of design and construction to adapt the Trinidad station to the Omega System was $1,427,529. Of this, about $386,492 was the cost of the antenna (design and construction).[10]

The $1,427,529 also included $17,992 in construction and installation spares, and $569,836 in expenses for buildings, roads, prime power, and other unspecified excludable items. Thus, the cost for adapting the Trinidad station (exclusive of station electronics) to the Omega system, in accordance with defendant's interpretation of the Bendix license, is $839,701.

102. The Trinidad station contains an FRA-31 Transmitter Group (which has only one transmitter, rather than an FRT-88 Transmitter Group which contains two transmitters) and also contains only three (rather than four) cesium beams. The total cost of the Trinidad Omega station electronics, including installation cost, design and development is $658,656. Thus, the total cost allocable to "transmitter" and incurred in establishing an Omega station at Trinidad was $1,498,357. ($839,701 plus $658,656).

103. The Trinidad station remained in operation along with the permanant stations at North Dakota, Hawaii, Norway, and Japan up to and beyond July 22, 1975, despite the fact that it was not equipped with a spare transmitter, had only three rather than four cesium beams, and lacked some redundant parts with which the other permanent stations are equipped.

104. The station at Norway was installed in March 1966 with a checkout of the station lasting from March through April 1966. The station initially transmitted only on a two frequency mode.

[10] Total of lines 1a, 2a, 3a, 4a, 6, 7, 8, and 11 of DA 41.

However, its station electronics were modified by February 1967 to provide a three frequency capability and transmission in that mode was effected by that date.

105. The total cost of constructing the Norway station was $1,905,717. This includes $107,000 which was the cost of erecting a test span at Novik, Norway, which never radiated a three frequency format. Of the total, $4,675 was for construction spares and $781,259 was excludable either under defendant's interpretation of the Bendix license definition of "transmitter" or as pertaining to the Novik test span. Thus, the cost of constructing and designing the Norway station allocable in accord with defendant's interpretation of the license definition of "transmitter" was $1,119,783. Including $569,940 for the installed station electronics yields a total allocable cost of $1,689,723.

106. The station at Haiku, Hawaii, was located at a former communications station. The only significant cost of adapting that communications station to an Omega station was the cost of installing the station electronics. Thus, the cost of adapting the Hawaii station to the Omega station was $562,301.

107. The station at Forrestport, New York, was located at an Air Force communications station which already had a 1,200-foot tower. A helix house was built at a cost of $30,000 (including shielding). While the Forrestport station had been used for Omega experiments as early as 1962, it did not acquire a two frequency capability until 1965. It was not equipped to transmit the three Omega frequencies (along with FT_1 and FT_2) until June 1967. In 1973, when the North Dakota station became operational, the Forrestport station reverted back to the Air Force.

108. The cost of adapting the Forrestport station for use as an Omega station was $30,000 for the helix house, plus $620,151 for station electronics, including installation, for a total of $650,151.

109. Two AN/ARN-99(XN-1) receivers (which were designed and developed by Northrop) were the first automatic three frequency Omega purchased by defendant from a manufacturer. No automatic three frequency receivers useable in the Omega system had been manufactured previously by a commercial supplier.

The two AN/ARN-99 (XN-1) receivers were procured under Naval Air Systems command (NAVAIR) contract N00019-68-C-0355 (dated February 29, 1968) with Electronics Division, Northrop Corporation. The contract was negotiated under the authority of 10 U.S.C. § 2304(a)(11). An option to procure two additional receivers, designated AN/ARN-99 (XN-2), was exercised under P006 in July 1969.

A cost proposal submitted by the Nortronics Division of Northrop contained a detailed estaimate of the cost of various tasks which were eventually performed under the '0355 contract. Task 1.3 estimated a cost of $358,318 for materials, fabrication, assembly, inspection, in-line testing, and functional acceptance testing of two receivers, Task 5.0 called for the materials, fabrication, assembly, inspection, and acceptance testing of the two receivers. This was estimated to cost $197,430. However, the '0355 contract, while encompassing the tasks set out in Northrop's cost proposal, did not specify these tasks with the same precision. The contract incorporated the proposal by reference at page 4. Thus, the actual manufacturing cost of the ARN-99(XN) receivers included items such as engineering services and data.

Northrop's cost proposal is indicative of the price which Northrop would ask for the ARN-99(XN) and (XN-2) receivers.

110. The following table indicates the line items procured under the '0355 contract, along with the prices paid for them:

Item	*Description*	*Estimated Cost*	*Total Cost*
1	(2) Engineering models and spares	$ 939,670.00	$1,188,619.00
1AA	Long lead time items for Phase II		Not Separately Priced
1AB	Repair and Maintenance services for item 1	17,777.50	19,373.00
1AC	Design data for item 1		Not Separately
1AD	Field Engineering for item 1 (1 man-year)	5,076.00	5,533.00
1AE	Qualification test of Omega Receiver/Buffer	86,116.00	93,866.00

Item	*Description*	*Estimated Cost*	*Total Cost*
2	(2) Service test models and parts	$ 414,246.00	$ 565,125.00
2AA	Design of special support equipment for item 2		Not separately priced
2AB	Design data for item 2		Not separately priced
2AC	Engineering Services for 2 man-years		Not separately priced
2AD	Provide repair and maintenance services for item 2	16,320.00	17,788.00
2AE	Provide training in maintenance and operation of item 2	7,336.00	7,996.00
2AF	Transportation for engineering under item 2AC	3,800.00	4,142.00
3	(1) model special test equipment and spares		Not Ordered
4	Design data for item 3		Not Ordered
5	Fabricate and test one Receiver/Buffer	37,375.00	90,739.00
5AA	Services necessary for repair and maintenance of item 5	9,174.50	10,000.00
5AB	Design data for item 5		Not Separately Priced
5AC	Field engineering for item 5	31,765.00	34,623.00
6	Ground support equipment for items 2 and 5	56,881.00	62,000.00
TOTAL		$1,625,537.00	$2,099,804.00

111. A total of 95 AN/ARN-99(V)1 receivers were ordered under NAVAIR contract N00019-72-C-0329, dated December 30, 1971, under line items 0001, 0023, and 0027. The ARN-99(V)1 receiver set consists of the following components: an OR-901 ARN-99(V) Receiver Converter; an AS-2623A/ARN-99(V) Antenna-Coupler; and an MT-4532/ARN-99(V) Mounting Base.

These sets include neither a computer nor a Control-Indicator. The average cost of each of these sets is approximately $22,444.72.[11]

Of the 95 receivers procured under the '0329 contract, a total of 31 were manufactured for, but not accepted, by the United States until after July 22, 1975. This included 24 receiver sets procured under line item 0023, 3 sets procured under line item 0001AB, and 4 sets procured under line item 0001AC in which the receiver-converters were disassembled into modules. Fourteen of the 95 AN/ARN-99(V)1 sets were assembled and installed in aircraft prior to July 22, 1975.

The '0329 contract called for delivery of the 24 receiver sets under line item 0023 after July 22, 1975. The line item of the 31 AN/ARN-99(V)1 sets under items 1AB, 1AC, and 23, undelivered as of July 22, 1975, is $690,735.52.

112. The following is a tabulation of the various line items and their respective prices under the '0329 contract for 165 receivers ordered prior to July 22, 1975:

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0001	ARN-99(V)1 set	70	$22,319.23	$1,562,346.36
0001AA[12]	"	22	32.28	710.16
0001AB[12]	"	11	12.27	134.97
0001AC[12]	"	37	32.28	1,194.36
0002	Reliability testing for item 0001	lot	—	435,337.00
0003	First article approval testing for item 0001	lot	—	218,766.00
0004	Engineering drawings, lists, microcards	lot	—	12,816.00
0005	First article test report	—	—	Not separately priced

[11] Based on prices for items 0001 (including additions under item 0001AA, AB, AC), 0023, and 0027 as shown in finding 112.

[12] Line items AA, AB, and AC are part of item 1, broken down as per funding source. The figures under unit price and total price are additions to the basic price of line item 1.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0006	Technical manuals	lot	—	$ 23,444.00
0009	Provisioning data	lot	—	16,085.00
0014	Maintainability program	lot	—	35,155.00
0015	Technical Data	lot	—	223,900.00
0017	Administrative/ financial data	—	—	Not separately Priced
0018	Integrated Logistic Support	lot	—	99,310.00
0019	Data for item 0018	—	—	Not Separately Priced
0020	Maintenance engineering analysis program	lot	—	22,058.00
0022	Reuseable container for AN/ARN-99(V)	50	$ 417.49	2,734.50
0023	AN/ARN-99(V)1 set	24	22,263.96	534,335.04
0027	AN/ARN-99(V)1 set	1	33,527.46	33,527.46
0028	Associate contractor services	500 hrs.	44.56	22,280.00
0029[13]	Repair services	lot	—	—
0030[14]	Shipping and storage containers for ARN-99(V)1	27	81.481	2,199.96[14]
0031[15]	AN/ARN-99(V) system safety program	lot	—	[15]
0032[15]	Data for item 0031	—	—	Not Separately Priced

[13] Under A00022, signed April 21, 1975, $1,500 was obligated for line item 29. The repair services were never required and, hence, this was deobligated by the Administrative Contracting Officer.

[14] The shipping cartons ordered under P00017, signed June 27, 1975 were not deliverable until October 1, 1975. Their price was $2,199.96.

[15] Not ordered until September 24, 1975, under P00018. This price was $14,100.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0033[16]	Disassemble AN/ ARN-00(V) sets to module level and repackage	lot	—	[16]
TOTAL				$3,246,333.81

113. A total of 20 AN/ARN-99(V)4 Omega receivers were procured under NAVAIR contract N00019-74-C-0372, dated February 11, 1974 with the Electronics Division of Northrop Corporation. The AN/ARN-99(V)4 receiver sets consisted of the following components:

(1) OR-133(V)2/URN Receiver-Computer (P.N. 61710600-602A)
(2) AS-2623A/ARN-99(V) Antenna Coupler (P.N. 60710900-601B)
(3) MT-4538/ARN-99(V) Mounting Base (P.N. 61717020-601A)
(4) ID-1776/ARN-99(V) Control Indicator (P.N. 61710450-605A).

Of the 20 receiver sets procured under the '0372 contract, 18 sets were delivered to the United States prior to the expiration of '816. The cost of the two ARN-00(V) sets procured under the '0372 contract, which were not delivered until after July 22, 1975, is $60,399.25 per set or $120,798.50. Only two of the 20 AN/ARN-99(V)4 receivers procured were assembled and installed in aircraft prior to July 22, 1975.

114. The following is a tabulation of the line items procured under the '0372 contract, along with their respective prices:

[16] Not ordered until May 10, 1976 under P00020. This price was $3,625.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0001	AN/ARN-99(V) 4 Navigational Set	20	$60,399.25	$1,207,985.00[17]
0002	Reuseable container for AN/ARN-99(V)4	20	85.00	1,700.00
0003	Reliability tests	20	10,477.00	209,540.00
0004	Technical data for item 0001	lot	—	92,448.00
0005	Technical manuals	—	—	21,600.00[18]
0006	Spare and repair parts for item 0001 (provisioned item)		—	23,444.00[19]
0008	Provisioning Technical data for item 0007	—	—	20,000.00
0009	Ground support equipment	—	—	16,085.00[20]
0010	Data for ground support equipment	—	—	18,740.00[21]
0016	Administrative provisional data	—	—	Not Separately Priced
0020	Computer programming documentation	—	—	116,359.00
0023	Spare and repair parts (item 0009)	—	—	[22]
0025	Integrated logistics support plan	—	—	95,760.00
0026	First article approval testing	lot	—	47,127.00
0027	First article test report	lot	—	12,026.00
0028	Operational logistic support plan	—	—	63,270.00

[17] Includes $12,185 definitized by A00022.

[18] An additional $252,231 was first obligated after July 22, 1975.

[19] An additional $145,736 was first obligated after July 22, 1975.

[20] An additional $328,758 was first obligated after July 22, 1975.

[21] An additional $16,300 was first obligated after July 22, 1975.

[22] The entire $20,000 was first obligated after July 22, 1975.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0029	Maintenance engineering analysis for peculiar ground support equipment	--	—	13,470.00
0033	Verification of interim level test equipment	—	—	7,500.00
TOTAL obligated prior to July 22, 1975				$1,967,054.00
TOTAL obligated after July 22, 1975				763,025.00
GROSS				$1,204,029.00

115. Under NAVAIR letter contract N00019-C-0268, dated January 3, 1975, the United States ordered 21 ARN-99(V)1 receivers and 8 ARN-99(V)4 receivers. This letter contract was superseded by Modification P2002, dated October 23, 1975. Both the original letter contract and the modification called for deliveries to commence in October 1975. This delivery schedule was not modified to provide for earlier deliveries. Thus, none of the line items of the '0268 contract were delivered to the United States prior to July 22, 1975. There is no evidence that any receivers under the '0268 contract were manufactured prior to July 22, 1975.

That contract called for the following unit prices for the following items:

OR-90/ARN-00(v) Receiver-Converter	$15,653
OR-133(V)2/URN Receiver-Computer	50,258
AS-2623A/ARN-99(V) Antenna-Coupler	1,516
MT-4534/ARN-99(V) Mounting Base	353
ID-1776/ARN-99(V) Control Indicator	8,813
	$76,593

116. NAVELEX entered into contract N0039-71-C-0126, effective February 26, 1971, with the Electronics Division of Northrop Corporation to develop software to adapt the ARN-99 (XN-1) to submarine use. This model was designated BRN-7. In designing the BRN-7 receiver (a three frequency Omega receiver

used aboard certain kinds of attack submarines) one of the two AN/ARN-99(XN-1) receivers previously procured was loaned to NAVELEX and adapted for submarine use. No hardware was procured under this contract; rather, the following items were supplied:

Item	*Description*	*Total Price*
0001	Modification kit (software) for AN/ARN-99 Omega receiver	$146,269.17[23]
0002	Data requirements	Not Separately Priced
0003	Factory training for four technicians in operation maintenance of (modified) AN/ARN-99	Not Separately Priced[24]

117. Under NAVELEX contract N00039-73-C-0209, accepted September 1, 1972, definitized by PZ0007, effective August 16, 1972, with the Electronics Division, Northrop Corporation, the United states ordered a total of 97 AN/BRN-7 receivers. This contract was the only production contract awarded prior to July 22, 1975 for the BRN-7 receivers. Of the 97 sets ordered, one under line item 0034 was purchased for the Government of France. Two other sets were not scheduled for delivery nor delivered until after the patent had expired. The average of ceiling prices of the 97 sets procured by the Government under line items 0002, 0020, 0034, and 0044 during the term of the patent was $53,002.04 per set for a total of $5,141,197.88. Of the 97 BRN-7 sets, 18 were installed prior to July 22, 1975.

An AN/BRN-7 receiver consists of the following components:

(1) Receiver Computer, OR-133/V/URN (P.N. 61710600-601A)
(2) Control Indicator, C-9461/BRN-7 (P.N. 61710450-602A)
(3) Interface Box, ON-128/WRN (P.N. 61716000-601A)
(4) Mounting Bases, MT-4610/WRN, MT-4611/WRN (P.N. 61717000-601A, 61718000-601A)
(5) Interconnecting cables, connectors, caps.

[23] *See* P00002, p. 2.
[24] *See* P00003, p. 1-2.

118. Four BRN-7 receivers were ordered as first articles, with first article testing to be performed by the contractor, under line item 0001 at a target cost of $407,710 each, the total target cost for the four items being $1,630,840. A ceiling cost of $1,797,037 was established in the contract.[25] These four sets were delivered to the Government under line item 0001. The Government returned the four first article items to the contractor, who reconstructed them and delivered the reconstructed items to the Government under line item 20 at a price of approximately $53,000 per receiver.

119. The following is a tabulation of the line items ordered under the '0209 contract:

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0001	First article BRN-7 receiver sets	4	$407,710	$1,797,037
0002	AN/BRN-7 receiver sets	35	48,100	1,855,070
0003	Interim repair parts	lot	—	1,165,000[26]
0004	First article program controller	4	117,947	519,867
0005	Program Controller	35	13,208	509,377
0007	Data (Exhibit A)	lot	407,729	449,280
0008	Instructional material	lot	18,511	20,397
0009	Instructional services	20 man-days	237.25	5,230
0010	Support for item 0009	lot	Est.	3,319[27]
0011	Data (Exhibit B)	lot	475	523
0012	Technical professional engineering services	167 man-days	243	40,581[27]
0013	Support for item 0012	lot	Est.	4,700[27]

[25] Ceiling prices will be treated as applicable for the '0209 contract, as 90 percent of the items under the '0209 contract are presently at ceiling price.

[26] Amount obligated as of July 22, 1975 following deobligation of $5,000 per modification A00002.

[27] Denotes target price.

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0014	Data (Exhibit C)	lot	$ 22,308	$ 24,581
0015	Maintenance repair parts (option exercised A007, 8, 13, 18)	lot	—	205,117[28]
0016	AN/SRN( ) Omega set	2	105,023	231,420
0018	Program controller	1	13,208	14,554
0020	AN/BRN-7 receiver set	53	48,100	2,809,106
0021	Interim repair parts	18 sets	19,877	258,401[29]
0022	Program Controller	53	13,208	771,362
0024	Establish repair and overhaul depot, and overhaul services	lot	447,085	447,085[30]
0034	BRN-7 for France[31]	1	48,100	53,002[31]
0035	Interim repair parts for item 0034[31]	lot	30,000	35,455[31]
0036	Maintenance repair parts[31]	lot	45,000	53,182[31]
0037	Program Controller[31]	1	13,208	14,554[31]
0038	Interim Repair parts for item 37[31]	lot	2,500	2,954[31]
0039	Maintenance repair parts Exhibit K[31]	lot	4,000	4,727[31]
0040	Technical Services foreign[31]	10 man-days	288	2,880[32/31]
0041	Support for item 40[31]	lot	Est.	620[32/31]
0042	Data[31]		Not Separately Price; included in item 37.	
0043	Interim repair parts Attachment D	lot	45,600	45,600[33]

[28] An additional $3,164,898 was obligated for spare parts ordered after the patent expired.

[29] Amount obligated as of July 22, 1975. Ceiling price is $301,750.

[30] Amount obligated as of July 22, 1975. Ceiling price is $510,000.

[31] Item purchased for Government of France.

[32] Denotes target price.

[33] *See* fn 30, *supra*.

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0044	AN/BRN-7 receiver sets	8	$ 48,100	$ 424,016
0045	Program Controller	8	13,200	116,360
0046	Interim repair kits	22 sets	21,300	468,600[34]
0047) 0048)	Tape Cassettes	200 Sets	75	[35]
TOTAL				$12,353,957

120. The BRN-7 receivers do not include an antenna/coupler as one of the components. Rather each receiver, when installed, is connected to the standard submarine antenna and antenna coupler. These antennae and coupler units are capable of receiving a range of frequencies from VLF to HF and, therefore, are not limited to use with the Omega system, but must be employed when the Omega system is used.

121. The '816 patent claims a hyperbolic radio navigation system. (*Decca*, *supra*, finding 19). Such a system requires the use of a combination of receivers and transmitters. (*Decca*, *supra*, finding 4(a), at 23). The claims of the '816 patent do not define the structure of the respective components, *per se*. The claims merely require that the receivers and transmitters function in the manner set forth in the claims to provide the intended result. (*Decca*, *supra*, finding 19; see finding 26). As procured, the ARN-99 and BRN-7 receivers consist of components as set out in findings 114, 116, 118, and 120. These components were interconnected during first article and production-line testing, the ARN-99 and BRN-7 receivers being tested with Omega signal simulators rather than with transmissions from established Omega stations.

122. The following are components of an AN/ARN-99 receiver:

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[34] *See* fn. 31, *supra*.

[35] *See* fn. 32, *supra*.

(1) a receiver-computer group, OR-133(V)URN;
(2) a control indicator, ID-1776/ARN-99(V);
(3) an antenna-coupler, AS-2623/ARN-99(V); and
(4) a mounting base, MT-( )/ARN-99

The following are components of an AN/ARN-99(V)1 receiver:

(1) a receiver-converter, OR-90/ARN-99(V);
(2) an antenna-coupler, AS-2623/ARN-99(V); and
(3) a mounting base, MT-4534/ARN-99(V).

The differences between the two models is of no legal consequence.

123. Before an ARN-99 or BRN-7 receiver can utilize the frequencies transmitted as part of the Omega system in a navigation platform (which may be a submarine, ship, or an aircraft), a survey must be made of the platform. Racks to hold the receiver-computer and control-indicator must be fabricated and installed. The task of installing and interconnecting the receiver-computer, control-indicator, and interface group takes a total of 240 manhours for special Navy installation teams. The cost of installing a BRN-7 receiver in a submarine, for example, is approximately $7,000. Similarly, the cost of having a contractor assemble and install an ARN-99(V)4 receiver in an EC-1300 aircraft is $15,895. This indicates an approximation of the amount of effort and cost required to install Omega receivers in submarines or aircraft.

124. The Government does not include certain components when ARN-99(V)1 and BRN-7 receivers are procured, since the antenna and antenna/coupler for the BRN-7 receivers are already aboard the submarines and the computers used with the ARN-99(V)1 receivers installed in aircraft are procured with the aircraft. In any event, the antenna and antennae/couplers are indispensable in use of the Omega system and the airborne computers enhance the value of the system in aerial navigation by providing a digital latitude/longitude readout. There is no evidence of record to establish the number or cost of the computers which were procured by the Government during the term of the '816 patent, either separately or as components of procured aircraft.

125. The '816 patented invention is "used" when a receiver receives and processes the Omega signals. (*Decca*, *supra*, at 19, 20). Manufacture of the components of receivers capable of receiving and processing Omega signals by or for the Government constitutes contributory infringement of the '816 patent by the contractor. Transmission of the Omega format and contracting for the manufacture of receivers capable of using that format constitute active inducement by the Government of infringement, both by contractors and nongovernment users of the format and receivers.

126. Of all ARN-99 and BRN-7 receivers procured by defendant, the following receivers were the only ones of which installation aboard their respective platforms was completed during the '816 term:

Type	*Qty.*	*Receiver Contract*	*Fiscal Year of Installation*	*Platform*
ARN-99(XN-1)	2	'0355	1969	P-3A, submarine
ARN-99(XN-2)	2	'0355	1971	P-3A/B
ARN-99(V)1	1	'0329	1973	P-3B
ARN-99(V)1	1	'0329	1974	P-3C

Type	*Qty.*	*Receiver Contract*	*Fiscal Year of Installation*	*Platform*
ARN-99(V)1	10	'0329	1975	P-3C
ARN-99(V)1	2	'0329	1974	CH-46E
ARN-99(V)4	2	'0372	1975	EC-130Q
BRN-7	18	'0209	1975	submarines

Generally, the above installation instances occurred in the latter half of the fiscal year. *Id.*

127. The patent in suit was first licensed by plaintiff through its wholly-owned subsidiary, Decca Navigator Company Limited [hereinafter DNCL] to the Bendix Corporation in November, 1961. Bendix was granted an exclusive license under the '816 patent, and 60 other listed patents, to manufacture and sell transmitters and receivers for the Decca Navigator and DECTRA Systems. Also licensed was technical information, including data, drawings, and assistance, as well as a right to use plaintiff's

trademarks. In consideration of the license, Bendix was to pay a 7.5 percent royalty on the net selling price of receivers, transmitters, and parts thereof. Royalties were received by plaintiff from Bendix under this license. Bendix was also given the right to sublicense all rights it had received for which it would retain a 2.5 percent share (that is, a one-third portion) of the 7.5 percent royalty paid by the sublicensee. Thus, if the Government obtained a license from Decca or a sublicense from Bendix prior to litigation, the 7.5 percent royalty rate would have been an established reasonable royalty rate.

128. Prior to the 1961 license to Bendix, plaintiff licensed Bendix to use a pool of 51 patents, know-how, and trademarks for the Decca Navigator System. The license was exclusive except as to one licensee of Decca, and Decca itself, in the case of marine navigation systems. The patent in suit was not licensed and had not yet issued; however, the compensation for these licenses was a 7.5 percent royalty on the net selling price of licensed equipment. The license was dated October 27, 1954 and granted a "* * * license to make, have made, use, lease and/or sell, only for short and medium range navigational aid purposes * * * Decca Navigator System transmitters and receivers covered by and/or coming within the scope of any of the Licensed Patents." Payments were required "* * * on all sales or leases of Decca Navigator System transmitters, receivers and/or parts thereof * * *." *Id.* at 7.

Soon after Bendix entered into the 1954 license with plaintiff, it began to manufacture Mark V receivers useable with plaintiff's Mark V Decca Navigator System. Bendix re-received data packages from plaintiff under the 1954 license.

129. Prior to issuance of the '816 patent, the 1954 Bendix license was amended in September 1957 to include four additional patents with no changes in the royalty rate or base. Thus, in accordance with normal patent licensing practices, the royalty rate for the patents, plus a license for use of know-how and trademarks did not change in the subsequent 1961 Bendix license, even though the '816 patent was added.

130. Beginning with the 1961 Bendix license, plaintiff defined "transmitter" in several licenses which included the patent in suit as follows:

> 'Transmitter' shall mean all the technical equipment used in the production of satisfactory and reliable Decca or Dectra service from, but not including, the primary power supply to, and including, the dispatch of the service, but shall not include land, building, vehicles, diesels, real property improvements and the primary power supply.

Plaintiff's licenses to Applied Science Industries [ASI], Winder Aircraft [Winder], Laboratory for Electronics [LFE], as well as Bendix's sublicenses thereunder, to General Precision, Decca Systems, Inc., LFE and ASI, contained essentially the same provisions. In paraphrase, transmitter royalties were to be paid on everything from the power source to and including the transmission antenna.

131. The 1961 Bendix license also required Decca to pay Bendix a royalty of 2.5 percent of the net selling price of transmitters, receivers, and parts thereof sold by Decca or its subsidiaries in the United States. This provision was to compensate Bendix for its development expenses in connection with the equipment manufactured for use with the Decca Navigator System. This provision required Decca to use the limited definition of transmitter in the 1961 Bendix license in its computation of royalties due Bendix. In making such computations, Decca "broke out" from the applicable royalty base by excluding diesel generator sets and batteries, as well as land, building, real property improvements, and prime power supply.

The 1961 Bendix license states that the 7.5 percent royalty on transmitters, receivers and parts thereof is "in consideration of the technical assistance and information furnished and to be furnished," as well as the "licenses granted and to be granted." In 1964, Laboratory for Electronics (LFE), which was a sublicensee of Bendix pursuant to the 1961 Bendix license, notified Decca that a royalty payment on unpatented spare parts might be objec-

tionable to the United States Army, as the consideration for such payments on unpatented parts might be considered by the Army to be payments for know-how.

132. Decca received grant-back rights to improvements developed by licensees. The data flow from Decca to its licensees, however, exceeded the data flow from the licensees to Decca under the grant-back provisions of the license.

133. Decca included the following provision entitled "Exclusion for Research and Development" in several license agreements which licensed the patent in suit in connection with Decca Navigator and Dectra Systems:

> In the case of sales or rentals under contracts involving research and development effort the net selling price or rental shall be an equivalent fair market value of the apparatus actually delivered and shall exclude payment received for research and development effort not directly reflected in the fair market value of the apparatus.

This provision also appeared in sublicenses as from Bendix to General Precision Decca Systems, Inc., [hereinafter GPDSI], and a tripartite license of DNSI and DNCL to Astronics relating to Hi-Fix equipment. Thus, Decca did not charge a royalty on payments made under an R&D contract which were for R&D services, rather than for the apparatus actually delivered.

Decca also included in several licenses a term defining net rental to include "the rental element only and not any amount payable for repair and maintenance service to be furnished pursuant to a contract with the Lessee".

134. On March 31, 1969, Decca, through Decca Navigator Systems, Inc., entered into a license agreement with ITT Navigator Systems, Inc. [ITT/NSI] in an arm's-length, voluntary transaction. Decca received royalties under this license. This agreement licensed ITT/NSI to make, have made, use, sell, and/or lease transmitters and receivers. The '816 patent was listed in Schedule A and noted as applicable to Basic Mark 10, Omega and DELRAC. The Mark X Decca Navigator System, which includes transmitters and

receivers, comes within the scope of claims 1 and 11 of the '816 patent. The license to ITT/NSI was exclusive, subject to existing licenses, but there was an understanding that plaintiff would allow its existing licenses with others to expire in October 1970 so that the license to ITT/NSI would become exclusive thereafter. By their terms, the other licenses granted under the patents in suit expired by that time, and Decca gave notice of the terminations.

135. Of the 29 patents listed in Schedule A and licensed to ITT for particular fields of use, only seven had been licensed under the 1961 Bendix license, of which only six had been licensed under the 1954 patent license. The remaining patents issued after November 11, 1961, the date of the 1961 Bendix license. Thus, at the time of execution of the ITT license in March 1969, Decca's patent portfolio was decreasing and its early patents relating to the Decca Navigator System had expired or were expiring.

136. The license to ITT/NSI had a first compensation clause which applied only to Decca Navigator and DECTRA transmitters and receivers, while a second clause applied to all other Licensed Equipment. No royalties were paid under the latter clause with respect to Omega or DELRAC receivers, since those items were not developed or made by Decca. However, it was applicable to Omnitrac computers, LORAN-C equipment, Roller Maps, Data Links, and Automatic Pilots which were developed by Decca. Compensation was to be paid by applying a royalty rate to the net selling price, F.O.B. factory, and exclusive of packaging costs, of the relevant items.

137. The clause applicable to "all other Licensed Equipment" provided a 5 percent royalty on licensed equipment presently in existence. Omega/Delta equipment would have fallen within the second part of the clause, if they came into existence. The royalty of 5 percent was payable for 5 years from the date of first sale or lease. After that, the royalty would decrease to 2.5 percent except for items covered by one or more unexpired, licensed patents. For these items, the rate would remain at 5 percent. This rate was agreed to, however, 4 years after the Government adopted and proceeded with implementation of the Omega system.

138. While ITT/NSI never marketed any Omega or Delrac transmitters or three frequency receivers, the license indicates an agreed valuation of a license under Decca's patents, including the '816 patent as of March 1969.

139. No definition of transmitter appears in the ITT/NSI license.

140. As of March 31, 1969, when the ITT license became effective, the requirements for station electronics for permanent Omega stations had been determined. Although defendant had proceeded with implementation of the three-frequency Omega system as of April 1, 1969, defendant planned to use two-frequency BRN-4 receivers (manufactured by ITT) in submarines which would utilize the Omega system. As of this time, the ARN-99(XN-1) had not been completed and installed for testing. As of April 1, 1969, the license to ITT was sufficient to enable it to supply station electronics for defendant's permanent stations. This was theoretically possible, not only in light of ITT's license, but also its prior experience with the Omega system. However, as a practical matter, it was unlikely in view of defendant's decision to be its own "prime contractor" for establishment of all Omega stations and receivers.

141. The royalty terms in the ITT license were the result of arm's-length bargaining after defendant had made known its plans for establishment of the Omega system. At the time the license was granted, several of plaintiff's early patents had expired, but the unexpired '816 patent was expected to be the dominant patent in the licensed portfolio.

142. ITT/NSI had a license not only to manufacture transmitters and receivers for the Omega and DELRAC systems, had such been developed, but it was also licensed to use them. Although ITT/NSI could have "used" the receivers and transmitters which it made, it was not licensed to build or operate a navigation system for which it made no components.

143. The royalty payable under an exclusive patent license, more often than not, is higher than that under a nonexclusive license. In this case, the "license" taken by defendant was the

equivalent of an exclusive license under the '816 patent, and all corresponding foreign patents owned by Decca, in view of defendant's preemption of Decca's worldwide exclusive rights.

144. In the electronics field, the Government normally seeks to include spare parts, installation costs, transportation costs, packing costs, data costs, and engineering service from negotiated patent licenses. This practice has been followed by the Government in negotiated licenses on radar, radio telephone, and telegraph systems. The base upon which the royalty rate is computed in such negotiated licenses is normally the cost to the Government, as charged by the supplier.

145. Frequently, when the royalty rate is applied to a high royalty base, a lower rate is negotiated. Conversely, when a low royalty base is expected, a higher royalty rate is frequently negotiated. Decreasing, sliding-scale royalty rates are frequently used in negotiated patent licensing to allow for reduction in royalty payments as the volume of sales or production increases. Decca, in two negotiated patent and know-how licenses pertaining to LORAN-C, used a decreasing sliding-scale royalty rate. "Most favored" licensee provisions are not uncommon in negotiated patent licenses. Such a provision is contained in at least two of Decca's negotiated licenses.

146. Armed Services Procurement Regulations [ASPR] § 9-409.4(c) provide that indirect Government in-house costs, such as overhead and supervision, are not to be included in royalty bases in negotiated Government licenses. However, Government-furnished materials are normally included in the base, priced at the Government's cost.

147. Royalty rates for negotiated licenses under patents on electronics systems range from as little as 1.5 or 2 percent up to 10 percent, and sometimes even more.

148. A study of Government patent licenses in the electronics field prepared by the Government's expert indicates that the Government, in a negotiated settlement, obtained a license for PPI (plan position indicator) radar, bearing a royalty for future

procurement at a rate of one-fourth of 1 percent, with a ceiling of $2,900,000, or an effective overall royalty rate of .178 percent. This, however, is an abnormally low percentage rate as compared with percentage rates negotiated between willing licensors and willing licensees. It is not usual to set a ceiling on royalties, but ceilings may be placed on negotiated royalties where the ultimate base is unpredictable. The ceiling, however, usually reflects what the parties agree is adequate compensation for use of the invention.

149. There never has been an arm's-length commercial sale of an entire Omega system from which a fair market sale price can be determined or upon which a royalty rate may be said to have been established. The nearest system, by comparison, is Decca's MK X system. It is a Low Frequency (LF) system which has a short range and smaller equipment but, otherwise, it is the same in principle as Omega, and is generically covered by the patent in suit. The technical problems of erection are substantially the same. Decca sold such systems as "turn key" jobs. Thus, the sale pricing methods used by Decca in the sale of its MK X systems are relevant. However, they are not totally comparable because the profit margin enjoyed by Decca in such sales was influenced by the fact that Decca's MK X system was in direct competition with the LORAN-C system for short-range usage. Also, Decca's MK X system did not offer an advantage of cost saving in the short range context anywhere near comparable to the $640 million more which LORAN-C would have cost over the Omega system, for worldwide coverage, or the capability of use by submerged submarines which the infringing Omega system provides. Accordingly, the profit mark-up for the sale of an entire Omega system should be at least equal to Decca's profit mark-up derived from its MK X system sales.

150. The fair market value of the tangible elements of the infringing Omega system to be included in the accounting also includes the fair market value of the receivers procured by the defendant. All procurements of the three-frequency receivers designated AN/ARN-99 and AN/BRN-7 up to July 22, 1975 are,

therefore, includable, plus 60 single frequency receivers. The 60 single-frequency receivers are includable on the ground that they were required for system calibration and monitoring. A receiver which indicated the position fix in terms of latitutde/longitude is also an element of the infringing system. Omega receivers, even those receivers which are implemented for rho-rho, employ the hyperbolic mode virtually all of the time. Thus, there is no substantial difference between the rho-rho and hyperbolic modes. Since all of defendant's activity in the procurement of equipment for transmitting stations and three-frequency receivers up to July 22, 1975 was intended for use in the infringing Omega system, such procurement was contributory to, or actively induced the infringement; hence, such procurement is includable in the compensation.

151. The infringing Omega system is unique. No other system has been shown to provide continuous, worldwide medium accuracy radio navigation, with ambiguity resolution comparable to that of the Omega system, or with accuracy for relative navigation as high as that provided by the infringing system. No other radio navigation system has been shown to be capable of being used effectively for submerged submarines. LORAN-C signals (the next-best alternative) penetrate only a few feet into sea water. Compared to the LORAN-C system, Omega was expected to afford a cost saving to defendant of over $640 million over a 10-year period. The operational cost saving on a single trans-Pacific voyage of a commercial surface vessel, by using the Omega system as compared with using any other available system, is as much as $5,000.

152. When defendant first made the Omega system operational on October 24, 1967, Decca lost its potential market for sale or licensing of a Delrac/Omega-type of system to defendant and all others. Based on Decca's computations, the total price of such a system as it existed on June 30, 1975 would have been $129,709,000. Decca estimates its profit on such a system would have been at least $22,167,000. If weight is given to the urgent military and non-military requirement for the Omega system and

the substantial saving to the Government by using the Omega system as compared with LORAN-A or LORAN-C, Decca would have been entitled to a profit mark-up higher than that used in its commercial sales of the MK X system, namely 30 percent. Based on such calculations, Decca estimates the cost of the system would be $139,805,000, which would include a profit of $32,263,000.

153. Plaintiff recognized in the definition of "transmitter" which appears in the 1961 Bendix license, that land, buildings, real estate improvements, vehicles, diesels, and prime power were not to be included as part of the royalty base upon which the licensees were to pay royalties.

154. There were no acts of infringment for which defendant is held liable after July 22, 1975, the expiration date of the '816 patent. Although the stations at LaReunion, Liberia, and Argentina, as well as the planned station in Australia, were not operational prior to July 22, 1975, defendant had contracted for all equipment associated with them prior to that date. The contract price of all ARN-99 and BRN-7 receivers for which contracts were executed prior to July 22, 1975, should be included in the compensation base, if procurement figures are to be used in arriving at the base, since defendant actively induced the contractor(s) to contribute to the defendant's ultimate infringement in the "manufacture[d] or use[d] by or for the government" of the Omega system.

155. If compensation is to be based on cost of establishing the system, the "entire market value" rule is applicable for purposes of determining the quantum of liability. Even though widely separated physically, each transmitter and receiver contributes to the system as a whole, and each performs a necessary function. For example, at each station the tower or valley span will not stand up without the entire system of guys, anchors, and foundations. The antenna will not radiate effectively without the insulators or the conductive ground system. The helix and transmitters, in order to assure continuous operation, must be housed in specially designed buildings. Redundancy of certain parts and spares is necessary due to the need for continuous "on air" capability. Everything within

the walls of the transmitting and monitoring stations is at least "reasonably" necessary. Virtually the entire procurement relating to Omega was financially tied to the market created by the patented system.

156. The 10.2 kHz frequency transmitted as one frequency of the Omega system is capable of noninfringing use. The Omega system, however, is utilized in initializing such receivers and the '816 patent is infringed whenever such a receiver utilizes the three transmitted Omega frequencies from at least two stations. The number and cost of receivers under procurement or installed as of July 22, 1975, thus may be taken into account in determining the compensation base.

157. The compensation base, even if computed on the basis of the lower ITT license and limited to the procurement costs of *only* the station electronics and receivers used in combination during the term of the '816 patent would be as follows:

Receiver Type	*Qty.*	*Unit Cost*	*Total Cost*
ARN-99(XN-1)	2	$192,480	$ 384,960
ARN-99(XN-2)	2	112,036	224,072
ARN-99(V)1	1	22,445	22,445
ARN-99(V)4	2	60,399	120,798
BRN-7	18	53,002	954,036
			$1,706,311

	Installed Cost	*Less Installation Cost*[30]	*Total Cost*
Station Interim:			
Hawaii	$562,301	$15,400	$ 546,901
Norway	569,940	17,800	552,140
Forrestport	620,151	16,200	603,951
Trinidad	658,565	21,750	639,906
			$2,339,898

[30] The installation costs can be identified by summing the costs for "installation" and "Travel & Per Diem" set out in DRF 78, pp. 42-43.

Permanent:	*Cost*	
North Dakota	$1,061,435	
Norway	1,061,435	
Hawaii	1,061,435	
Japan	1,061,435	
	$4,245,740	
Receivers		$1,706,311
Interim Station Electronics		2,339,898
Permanent Station Electronics		4,245,740
		$8,291,949

158. Defendant's actions were more than a mere taking of a nonexclusive license since the effect of those actions was to preempt the world market for plaintiff's goods, services, and patent rights. Moreover, defendant's actions left Decca completely at defendant's mercy as to Decca's future manufacture, licensing, or sale or the nature and scope of receivers, since defendant would have control of the transmission segment of the system. Accordingly, when defendant, for reasons of its own, ordered a cut-back in funds for completion of the Omega system in 1972, the procurement of receivers was affected. Decca, however, was not in a position to go out and make up for the reduced market, since it nor anyone else would be likely to build additional transmitters. The availability of such an option had been permanently preempted by defendant's overt implementation of the Omega system. Accordingly, the extent of defendant's actual use of the rights it took under the eminent domain license is not a complete measure of the value *to Decca* of the rights which were taken by defendant.

159. Plaintiff's license to ITT/NSI provided a royalty rate of 5 percent for an exclusive license in its patents, including the '816 patent in suit. The United States, having taken a nonexclusive license in the '816 patent by eminent domain prior to the granting of the ITT/NSI license, caused plaintiff to accept a reduction in the royalty rate from ITT/NSI as compared with that provided under

the Bendix license. Since plaintiff was not given an opportunity to bid on the establishment of the Omega system for defendant, plaintiff lost its opportunity to make and sell Omega transmitters and to control use of the Omega system. The 5 percent royalty rate, therefore, should not be considered a reasonable rate, but a forced minimum.

160. Since the royalty rate for an exclusive license may be 50-100 percent higher than that for a nonexclusive license, a reasonable royalty under the ITT/NSI license, if truly exclusive, would have been at least 7.5 percent. The Government's contribution in developing the sophisticated Omega station electronics and receivers which it used was insignificant in comparison with the total cost of establishing the worldwide Omega system. No decrease in the royalty rate is warranted on account of defendant's in-house development, since the value of such contribution, if any, was taken into account in the prices paid for the components procured from defendant's suppliers. Taking into account all of the evidence in this case, Decca would not have granted defendant a license to establish the worldwide Omega system for a royalty of less than 10 percent of the cost of establishing the system if constructed on a competitive bid basis.

161. It is a sometimes practice in the patent licensing field to use a step or decreasing sliding-scale royalty to provide for decrease of royalty rates to the patentee as the base increases or, conversely, for the increase of royalty rates as the base decreases. In some cases decided by this court a 3 percent royalty has been applied to the first $5 million of the base, and a 2 percent royalty on all amounts over $5 million. A sliding-scale royalty is inappropriate in the present case since the single infringement (establishment of the worldwide Omega system) saturated not only the domestic (United States), but also the foreign (worldwide) market for the system, the components of the transmitting stations and licenses under plaintiff's domestic and foreign patents. Where the royalty is based on savings to the licensee, it is proper to prorate the estimated savings over the life of the patent, starting from the date of first exercise of the licensee's right under the patent.

162. Defendant's declaration of "Operational" Status for the Omega system on October 24, 1967 was the first infringment in terms of use of plaintiff's rights, at least in the sense of inducement, and the use of the interim system with a bank of three single frequency receivers (each tuned to a separate one of the Omega frequencies) was a complete, direct infringement by defendant. Therefore, delay damages should start as of October 24, 1967, and be computed at the rates set forth in *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978). To account for the continuing nature of defendant's infringements, the basic award of $24.8 million is prorated from this date to the date of expiration of the patent (July 22, 1975). The award is not prorated uniformly over this entire time period, however, because it is clear that the Government did not immediately realize the full economic benefit of the Omega system during the early stages of its infringement. Accordingly, the award is prorated based on the empirical projection that the Government did not realize the full economic benefit of the Omega system until 1971, and that it realized only half of the system's economic benefit during the infringement period prior to 1969.

163. Rates of delay compensation to be applied to the compensation base (basic compensation) are as follows:

10/24/67-12/31/70	6.5 percent
1/1/71-12/31/75	7.5 percent
1/1/76 to payment	8.0 percent

164. Delay compensation is measured by simple interest running from the first day on which the royalty became payable. In this case, royalties first became payable on October 24, 1967 when the Omega system was first declared operational by defendant, and the operation thereof was guaranteed by defendant for at least one full year. Royalties for subsequent years became due at the end of each calendar year.

165. Based on the delay compensation rates specified in finding 163, the yearly delay compensation owed by defendant on the basic $24.8 million award, prorated in accordance with finding 162, is as follows:

Year	*Prorated Base (Annual Increment in Millions*	*Delay Compensation Rate*	*Delay Compensation*
10/24/67-12/31/67	1.0	6.5	$ 12,109
1/ 1/68-12/31/68	1.5	6.5	162,500
1/ 1/69-12/31/69	3.0	6.5	357,500
1/ 1/70-12/31/70	3.0	6.5	552,500
1/ 1/71-12/31/71	3.5	7.5	900,000
1/ 1/72-12/31/72	3.5	7.5	1,162,500
1/ 1/73-12/31/73	3.5	7.5	1,425,000
1/ 1/74-12/31/74	3.5	7.5	1,687,500
1/ 1/75-7/22/75	2.3	7.5	1,034,465
7/23/75-12/31/75	24.8	7.5	820,436
1/ 1/76-3/31/79	24.8	8.0	6,441,205
		Total Delay Compensation (Up to and including March 31, 1979)	$14,555,715
		Total Basic Compensation	$24,800,000
		Total (Reasonable and Entire) Compensation (Up to and including March 31, 1979)	$39,355,715
		Further Delay Compensation (April 1, 1979 to date of payment of judgment)	$5,436/per day

166. Defendants calculations of basic compensation and delay compensation thereon, which are rejected, are as follows:

Fiscal Year	*Item*	*As Installed Procurement Cost*	*Apportionment Factor*	*Apportioned Cost for Base*	*Royalty Rate*	*Royalty*	*Cumulative Rate*	*Delay Compensation to 12/31/77*
1969	*Basic 10.2 Electronics*							
	Hawaii - Interim	$ 488,901	0.047	$ 22,978				
	Forrestport - Interim	456,751	0.047	25,697				
	Norway - Interim	496,540	0.047	23,337				
	Trinidad	585,256	0.047	27,507				
	11⅓ and 13.6 Add-On							
	Hawaii - Interim	73,400	0.658	48,297				
	Forrestport - Interim	73,400	0.658	48,297				
	Norway - Interim	73,400	0.658	48,297				
	Trinidad	73,400	0.658	48,297				
	Station							
	Forrestport - Interim	30,000	0.047	1,410				
	Norway - Interim	1,119,783	0.047	52,630				
	Trinidad	839,701	0.047	39,466				
	Two ARN-99(XN-1)	416,750	1.0	416,750				
	Fiscal Year Total	$4,817,282		$802,963	1.8%	$14,453	62.25%	$8,997

Fiscal Year	Item	As Installed Procurement Cost	Apportionment Factor	Apportioned Cost for Base	Royalty Rate	Royalty	Cumulative Rate	Delay Compensation to 12/31/77
1971	Two ARN-99(XN-2)	$ 255,862	1.0	$255,862				
	Fiscal Year Total	$ 255,862		$255,862	1.8%	$ 4,606	48.75%	$ 2,245
1973	*North Dakota*							
	Basic 10.2 Electronics-	852,593	0.047	40,072				
	11⅓ and 13.6	127,849	0.658	84,125				
	Add-On Station	3,275,607	0.047	153,954				
	One AN/ARN-99(V)1 in P-3B	38,340	1.0	38,340				
	Fiscal Year Total	$4,294,389		$316,491	1.8%	$ 5,697	33.75%	$ 1,923
1974	*Norway*							
	Basic 10.2 Electronics-	743,887	0.047	34,963				
	11⅓ and 13.6	122,241	0.658	80,435				
	Add-On Station	2,145,985	0.047	100,861				
	Fiscal Year Total	$3,012,113		$216,259	1.8%	$ 3,893	26.25%	$ 1,022
1975	*Hawaii*							
	Basic 10.2 Electronics-	962,209	0.047	45,224				
	11⅓ and 13.6	126,070	0.658	83,954				
	Add-On Station	3,595,756	0.047	169,001				

(Continued on next page)

Fiscal Year	Item	As Installed Procurement Cost	Apportionment Factor	Apportioned Cost for Base	Royalty Rate	Royalty	Cumulative Rate	Delay Compensation to 12/31/77
1975	*Japan*[37]							
	Basic 10.2 Electronics-	$ 852,593	0.047	$ 40,072				
	11⅓ and 13.6	127,849	0.658	84,125				
	Add-On Station	3,275,607	0.047	153,954				
	Two[38] ARN-99(V)4	152,588	1.0	152,588				
	Eighteen[38] BRN-7	1,080,036	1.0	1,080,036				
	Fiscal Year Total	$10,172,708		$1,807,954	1.8% on 1st $408,425 (so that cumulative base equals $2,000,000) and 1.5% on balance of $1,399,529	$ 7,352	18.75%	$ 1,378
						$20,993	18.75%	3,936
TOTAL		$22,552,354		$3,399,529[39]		$56,994[40]		$19,501

[37] The procurement cost figures used for Japan are those for North Dakota, since Japan designed and constructed its own station using U.S. furnished station electronics, bushing, and some services. From DRF 72, the actual cost to the United States was: $629,211 for "Basic 10.2 Electronics," $109,719 for "11⅓ and 13.6 Add-on" and $86,541 for "Station." The use of the higher North Dakota figures, rather than the actual costs borne by the United States results in increases in the total royalty and delay compensation.

[38] One ARN-99(V)4 and four BRN-7 receivers were actually installed in July 1975. To simplify calculation, include in FY 1975.

[39] Difference between total of $3,399,529 and $3,399,528 in DFR 139(d), p. 96, *supra*, is attributable to rounding off to nearest whole dollar.

[40] Difference between total of $56,994 and $56,993 in DRF 144, p. 102, *supra*, is attributable to rounding off to nearest whole dollar.

CONCLUSION OF LAW

Upon the findings and foregoing opinion, which are adopted by the court, the court concludes as a matter of law that plaintiff is entitled to recover the sum of twenty-four million, eight hundred thousand dollars ($24,800,000.00) as basic compensation, and the sum of fourteen million five hundred fifty-five thousand seven hundred fifteen dollars ($14,555,715.00) as delay compensation through March 31, 1979, plus further delay compensation at the rate of five thousand four hundred thirty-six dollars ($5,436.00) per day from April 1, 1979 to the date of payment of the judgment.

UNCLASSIFIED

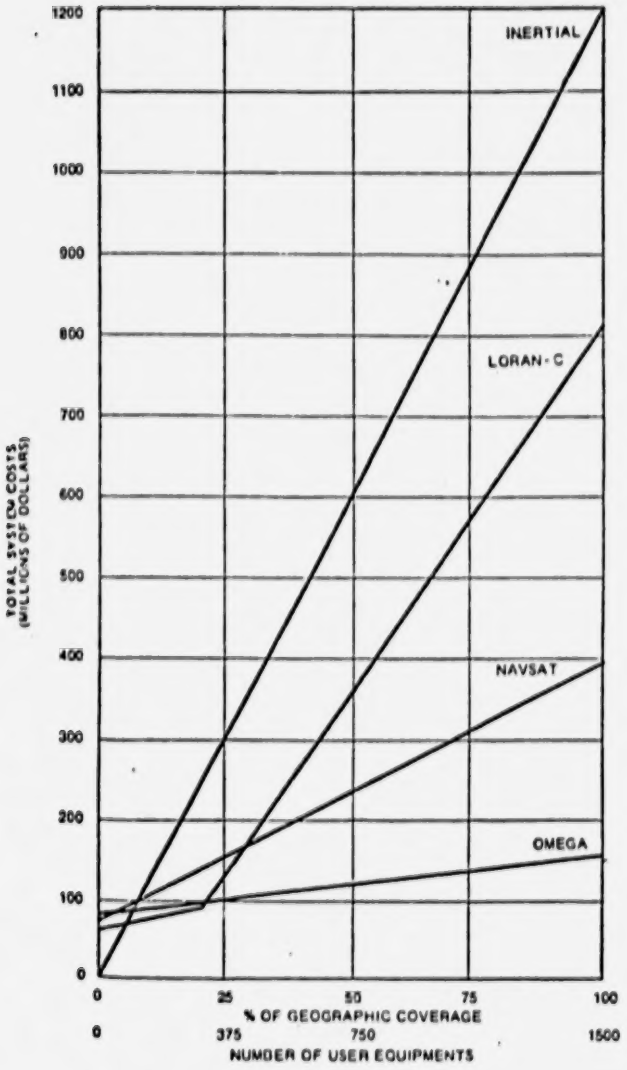


Figure 5-4. Total System Costs vs. Percent Geographic Coverage for Candidate Navigation Systems

United States Court of Claims

No. 299-70

DECCA LIMITED

v.

THE UNITED STATES

Before NICHOLS, *Judge*, Presiding,
KASHIWA and SMITH, *Judges*.

ORDER

This case comes before the court on defendant's motion, filed December 3, 1980, to amend judgment under Rule 151 and on plaintiff's motion, filed December 4, 1980, for rehearing *en banc* pursuant to Rules 7(d) and 151(b) with reference to the opinion entered November 19, 1980. Upon consideration thereof, together with the responses in opposition thereto, without oral argument, by the seven active Judges of the court as to the plaintiff's suggestion for rehearing *en banc* under Rule 7(d), which suggestion is denied, and further having been so considered by the panel listed above as to the parties' motions for rehearing under Rule 151(b),

IT IS ORDERED that the parties' motions for rehearing are denied.

BY THE COURT

(s) PHILIP NICHOLS, JR.
PHILIP NICHOLS, JR.
Judge, Presiding

Jan. 9, 1981

FINDINGS OF FACT OF THE TRIAL JUDGE INCLUDING INDICATION OF THE ADDITIONS (UNDERLINED) AND DELETIONS (BRACKETED) MADE BY THE COURT OF CLAIMS IN ITS ORDER OF NOVEMBER 19, 1980 REPRODUCED ABOVE.

23.[1] Pursuant to Rule 131(c), further proceedings were conducted to determine the amount of reasonable and entire compensation due plaintiff under 28 U.S.C. § 1498 (a) for the unauthorized manufacture or use by or for the Government of the subject matter of claims 1, 4, and 11 of United States Patent No. 2,844,816 entitled "Radio Navigation Systems" (hereinafter "the '816 patent") which issued on July 22, 1958 and expired on July 22, 1975. The claims were determined to be infringed by defendant in an earlier, separate liability proceeding. *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F.2d 1070, 191 USPQ 439 (1976).

24. The '816 patent relates to a hyperbolic radio-navigation system wherein transmitter systems at two or more locations each emit three harmonically-related signals which[, when] are received by a [system] receiver capable of analyzing the three frequencies [received, determine] and of indicating the geographic position of the receiver.

25. Decca [developed and] recommended to defendant's agencies in 1954 (prior to defendant's taking of Decca's patent rights) a system which it called the DELRAC Navigation

[1] Findings 1-22 are part of the court's judgment reported in *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 544 F.2d 1070, 191 U.S.P.Q. 439 (1976), and are incorporated herein by reference.

System. The salient feature of the DELRAC system was that it was a three frequency system (10.2 kiloHertz (kHz), 13.6 kHz and 11 ⅓ kHz) which would provide ambiguity resolution to a distance of ± 36 nautical miles (n.m.) in two stages of Lane identification. It was the first system capable of affording a continuous worldwide medium accuracy coverage and it is the only system which could be used effectively by submarines submerged to depths of more than a few feet.

26. The infringement is based on defendant's adoption, procurement, and use of a navigation system (which defendant called the "Omega" system) made up of a combination of very low three-frequency (VLF) transmitters and three-frequency receivers. Defendant's transmitters normally include an [AN/FRM-30] AN/FRN-30 Timing and Control Set (including four cesium beam standards), and AN/FRT-88 Transmitter Set, and an AN/FRQ-18(V) Tuning Set including a shielded, tunable helix coil and antenna. These are the principal components of the "station electronics." In addition, auxiliary items normally present at each station (not mentioned in the liability opinion) include shelters for equipment, housing for personnel, roadways, prime power equipment, backup power equipment and some other items of no consequence in this phase of the case.

27. Although from 1954 on, defendant had been aware of Decca's DELRAC system and its proposal thereof to defendant, defendant did not adopt the system or proposal at that time, but instead, over the next ten years or more, explored the possibility of employing various forms of noninfringing systems, including single and double frequency modes. None of those noninfringing systems, however, was ever completely developed by defendant to the point of permanent implementation.

28. Defendant ultimately designed the Omega system, to fulfill its desire for a worldwide, all-weather radionavigation system.

29. Prior to building and operating the Omega system, defendant had installed and operated LORAN-A and LORAN-

C systems to provide navigation and assistance in the coastal confluence regions of the United States as well as other areas. LORAN-A is a MF (medium frequency) hyperbolic radionavigation system. LORAN-C is an LF (low frequency) hyperbolic navigation system. LORAN-C has a greater range and accuracy than LORAN-A. Together these two systems provided coverage for most of the Northern Hemisphere prior to establishment of the Omega System. However, neither LORAN-A nor LORAN-C has the range necessary to provide cost-effective worldwide coverage.

30. The use of VLF signals in the 10-15 kHz region set aside for navigation allows the Omega system to provide cost-effective worldwide coverage with only a fraction of the number of stations which would be required to provide worldwide coverage with LORAN-A or LORAN-C.

31. In 1958, prior to the establishment of the Omega program and about the time the '816 patent was issued, the Naval Electronics Laboratory (NEL) was experimenting with a VLF hyperbolic navigation system called the [RADUX] Radux-Omega system.

32. In about 1962-63 (about five years after the '816 patent issued), the Navy experimented with systems employing very low frequencies (VLF) from transmitters located in Balboa, Panama Canal Zone; Haiku, Hawaii, and Forrestport, New York. Subsequently, transmitters were also installed at Trinidad (in the Carribean) and Norway. All of the stations were used to test the concept of having a few geographically-dispersed transmitters cover a large portion of the world.

33. In 1963, defendant evolved a "Technical Development Plan" (TDP) for a two-frequency VLF system (10.2, 13.6 kHz), which system would provide continuous worldwide, all-weather navigation and could be used by submerged submarines. The TDP also called for development of a two-frequency receiver with automatic dead reckoning and coodinate conversion for use aboard aircraft. The TDP also contemplated conversion of the existing transmitters at Forrestport, New York, and Haiku, Hawaii, from single-frequency mode to two-frequency mode.

34. During the 1962-63 timeframe, a group of experts designated as the Omega Implementation Committee (OIC) was hired by the United States to develop a complete technical layout for implementation of the three-frequency Omega system. In June, 1964, the OIC released the first edition of its report which defined a worldwide system consisting of eight Omega stations with average separations of about 5,000 nautical miles. The report contemplated resolution of lane ambiguity by using VLF transmissions of 10.2, 13.6 and 12.75 kHz, as well as other frequencies. The report, in effect, cleared the way for implementation of the Omega system and virtually preempted Decca's patent position, not only in the United States, but throughout the world.

35. Prior to June 1, 1964, Decca had been actively trying to persuade potential users to adopt its DELRAC system as a worldwide navigation system. These effort started as early as 1954 when plaintiff not only circulated its proposal to defendant's agencies but also, through representatives of the United Kindom (U.K.), proposed the DELRAC system to the International Commercial Aviation Organization (ICAO) at its meetings in 1954 and 1957. A description of the DELRAC system had also been published in Radio Aids to Civil Aviation (1960). However, as of June 1, 1964, Decca's potential market for its DELRAC system became reduced to defendant alone, as both the U.K. and ICAO ceased dealing with Decca with respect to building or operating the DELRAC or any other navigation system.

36. On June 1, 1965, a project was established by the Chief of Naval Materiel (referred to as a CNM-Designated Project) in which the Omega Project Office, (PM-9, later PME-119), was established, with overall responsibility for establishment and operation of the Omega system. Captain Mavis X. Polk was placed in charge of the project.

37. At the time of the establishment of the Omega system as a "CNM-Designated Project," Decca possessed sufficient

qualifications to bid on the construction and operation of the system as the prime contractor. Decca was then, and still is, a leading manufacturer of complete systems employing the teachings of the '816 patent. None of Decca's licensees was either licensed or equipped to construct or operate complete VLF systems in 1965 and prior to establishment of the Omega system, defendant had never constructed or operated one. By establishing Omega as a "CNM-Designated Project," defendant, [in undertaking] undertook the role of "prime contractor" for the Omega project. [preempted the field in building and operating a worldwide Omega/Delrac-type system.]

[38. Normally, for the purpose of policing its patent rights, Decca reserved to itself the role of prime contractor to build and/or operate navigation systems. It had already performed all of the necessary R&D and engineering of such systems; would have been willing to make the site selections for the transmitters; prepared to manufacture all of the electric and electronic components, including first order spares, and was capable of designing and procuring all of the station equipment including antennas, buildings, etc. Decca normally subcontracted (but supervised and was responsible for) all site preparations and station construction for installations for which it was the prime contractor. It installed, tuned and tested the system operation, instructed the customer's personnel, and performed initial start-up and "de-bugging" type operations. Certain items such as tower erection and building construction were normally subcontracted out, but plaintiff retained technical responsibility for them, included them in the total price of the system, and applied thereto the normal Decca general and accounting costs (G&A) and profit mark-ups. Decca, in fact, sold a Decca MK X system to defendant for use in defendant's AUTEC project in the Bahamas in the above-described manner, *i.e.*, as a complete "turn key" job. In the AUTEC sale, defendant's auditor inspected plaintiff's pricing methods including its G&A and profit mark-ups and did not disapprove them.]

39. Defendant began letting contracts in July 1965 for the construction of four, three-frequency transmitting stations which were intended to have "Interim Operational Capability" (IOC). The four stations were to be located at Trinidad (V.I.), Haiku (Hawaii), Forrestport (New York), and Bratland (Norway). A partial valley span antenna and certain roads and World War II buildings already existed at Haiku, and there were already buildings, roads and a communications antenna at Forrestport, New York. Defendant, therefore, did not need to build those stations completely. Trinidad and Norway, however, had to be built virtually from the ground up. The contract for the Norway station was let on July 29, 1965. The Trinidad station required two contracts. No copies of one of the contracts could be found, but from the testimony it is concluded that it was let no later than August 1, 1965. The other contract for Trinidad was let on August 12, 1965. The IOC stations were intended for the eventual transmission of the full, infringing Omega format. Trinidad, the first of the IOC stations to transmit, had "essentially a real Omega capability," that is, it transmitted the full 10.2 kHz, 13.6 kHz and 11 ⅓ kHz format.

40. Feasibility of the concepts to be employed in the Omega system were tested in 1966-67 through the network of the four IOC stations (Forrestport, New York; Trinidad; Haiku, Hawaii, and Bratland, Norway). The Trinidad station had the capability of transmitting and actually transmitted a three frequency Omega format consisting of 10.2, 11 ⅓ and 13.6 kHz signals on a test basis in February 1966. The Norway station transmitted in three frequency mode in February 1967, and the Haiku station in May 1967.

41. Defendant began seeking bids for three frequency transmitter component design as a consequence of the successful tests in February 1966, and by June 1966 was soliciting bids for three frequency *receivers* from as many as 18 manufacturers. Captain Polk testified that six companies had made

bread-board *receivers* "in anticipation of the contract we [the United States] put out." Since defendant's three frequency receiver solicitation started in June 1966, the companies which built the "bread boards" must have done so well prior to June [1967] 1966. The use of those "bread boards," together with three frequency Omega format signals from Trinidad, was sufficient to accord operational capability to the patented method of Omega signal processing even though the signals were being transmitted from that one station only. Since the signals from additional stations are a mere duplication of those from any other station (but for the differences in phase due to differences in distance), signals from a single station can be compared to those of a stable oscillator simulating a second station to illustrate how the system will work. [Therefore, the use of the "bread boards" prior to June 1967 was at least an experimental use for the United States in the 1966-67 period.] By September 30, 1967, defendant was operating a bank of three single frequency receivers, which were set up to receive the Omega signals [and, by manual operation, demonstrated the mode of operation of the patent in suit. This constituted an experimental use-type infringement.] By manual (human) processing of the data provided by the receiver bank, the position of the receiver bank could be determined. Neither a phase indicator nor a mechanical equivalent thereof was a component of the receiver bank.

42. In June 1967, the Secretary of the Navy requested that the four stations (Forrestport, Trinidad, Hawaii, and Norway) be declared operational and that the Navy be designated the Department of Defense (DOD) Executive Agent responsible for exploitation of the Omega system.

43. On October 24, 1967, the Secretary of Defense responded by authorizing the Navy to accord operational status to the four stations and to program funds for the Omega system through the fiscal year (FY) 1969. The Secretary of Defense emphasized the potential of navigation satellite systems and requested the Joint Chiefs of Staff (JCS) to take a further review of cost effectiveness of such navigation systems. However, a Program Change Decision was made on September 6, 1968, without waiting for the cost studies by JCS or the Department of Transportation (DOT). That decision provided for a permanant worldwide Omega system, and gave the Navy authority to

maintain the four-station Omega network and to construct four additional stations, subject to host countries agreeing to participate in the funding and operation of the additional stations.

44. Thus, on October 24, 1967, all four stations (Aldra, Norway; Haiku, Hawaii; Forrestport, New York and Trinidad) were declared operational. This meant that the Government guaranteed that these stations would transmit the Omega format for at least a year. At that time, although there were a number of operational single frequency receivers which could take advantage of the 10.2 kHz signals which were being transmitted from the four stations, there were no three frequency receivers in quantity production which could use the 10.2, 11 ⅓ and 13.6 kHz signals to resolve lane ambiguity. [During that same time, however, the Navy contracted for delivery of 140 AN/SRN-12 single frequency (VLF) receivers to replace the LORAN-A (MF) receivers in some of its surface fleet in anticipation of the use of the VLF receivers in connection with the Omega system. The foregoing acts constituted contributory and active inducement of infringement, as well as manufacture for the United States. As of October 24, 1967 the "taking" was consummated. As of this date, cost savings began to accrue to defendant's benefit.]

45. The eight permanent transmitting stations planned for the Omega system were to be located in North Dakota, Hawaii, Norway, Japan, Argentina, Liberia, LaReunion Island, and Australia. As of July 22, 1975 (the date of expiration of the '816 patent), construction of the stations at North Dakota, Hawaii, Norway and Japan had been completed, wherefore, infringement by those stations commenced prior to expiration of the '816 patent. Construction of the stations at Argentina, Liberia, and LaReunion was not completed as of that date. The latter three stations had not yet started to emit the three frequency Omega signals since the helix coils at those stations, although installed, had not been "tapped" (as of July 22, 1975) to permit emission of the signals as prescribed in the Omega format. Con-

struction had not yet begun on the Australian station as of July 22, 1975, although contracts had been let for all essential material for construction of the station and all station[,] electronics for that station were in possession of defendant.

46. In the Omega system, as built and used by defendant, the infringing three frequency format is *always* transmitted (except when one or more of the three frequencies is temporarily off the air for maintenance). There is never an intentional period of transmission of a [noninfringing] format [(*i.e.*,] less than three frequency[)], and the three frequency format is described by defendant as a "frequency requirement for all Omega stations."

47. The station electronics for each permanent Omega station include, among other things:

1. Omega Timing & Control Set AN/FRN-30
2. Omega Tuner AN/FRQ-18(V)
3. Omega Transmitter AN/FRT-88
4. A helix coil wound at the station site
5. Antenna

It is the combination of the foregoing items which enables the stations to transmit signals in the three frequency Omega format.

48. Each of the Timing & Control Sets, AN/FRN-30, (item 1, finding of fact 47) consists of eight unit racks, plus associated accessories. Unit Racks 1-6 are located at the site of the Omega station and function to generate up to five VLF signals in a predetermined format and control their transmission. Unit Rack 7, also located at the station, is a Digital Data Processor-Recorder Group which displays the data for each separate VLF signal received by the monitor receiver. Unit 8 is a receiver unit which is located a short distance from the transmitter to monitor the VLF signals transmitted by the associated station, along with those from other stations in the system. The Timing & Control Set contains the cesium beam frequency standards used to maintain the Omega signal format. While four cesium beam standards are present in the Timing & Control Set, only three form a part of the voting circuit, the fourth being an in-place spare which is kept activated because cesium beams will deteriorate if they are not kept energized.

49. The Antenna Tuning Set, AN/FRQ-18(V), (item 2, finding of fact 47) sequentially applies the 10.2, 11 ⅓, and 13.6 kHz signals to the proper taps on the helix coil in order to sequentially fine tune the helix coil and the antenna for transmitting these frequencies. Each Tuning Set contains six variometers, each with its associated gearbox, transmissions, control box, vacuum relay, and relay driver. One variometer assembly is an in-place spare. Each of the others is used for fine-tuning the antenna to transmit the VLV signals (*e.g.*, 10.2, 11 ⅓, and 13.6). Only three of the six variometers are required to enable transmission of the 10.2, 11 ⅓, and 13.6 signals for the claimed combination.

50. Each transmitting Set, AN/FRT-88 (item 3, finding of fact 47), contains two identical transmitter groups. One is connected to receive an RFsignal from the Timing and Control Set, amplify it through a series of amplifiers, and pass it through a matched out-put via the helix coil to the antenna which radiates the signal. The other transmitting group is an in-place spare which is connected to a dummy load. The two may be manually switched to allow the spare transmitting group to function while the other transmitting group is out of service. The stations in Hawaii, New York, Trinidad and Norway did not and do not have a spare transmitter group.

51. A receiver capable of using the Omega signals to indicate position is needed to utilize the Omega system. Receivers are "initialized by use of the Omega format, but may thereafter be operated for a period of time without reliance on the Omega format or by continuing to use the three frequency Omega format. An advantage of the Omega system is that it allows the user to initialize the system with the multiple frequency (10.2, 11 ⅓, 13.6 kHz) mode and thereafter use either the three frequency or the single frequency (10.2 kHz) mode. Surface ships, for example, can satisfy their minimum navigation requirements by using a simple 10.3 kHz receiver, such as the AN/SRN-12, with the aid of strip charts and dead reckoning, if lane resolution of lanes greater than 8 miles is adequate.

52. The AN/SRN-12 receiver was approved for service use with the 10.2 kHz signal of the Omega system. The receiver can indicate position within an 8-mile lane, but cannot, by itself, resolve lane ambiguity. As of July 22, 1975, when the '816 patent expired, there were at least 450 AN/SRN-12 receivers already installed aboard Government surface craft. In addition, 40 Tracor single frequency receivers had been used by the Navy for navigation. Ships using a single frequency receiver, such as the AN/SRN-12, can take advantage of the 10.2 kHz signal of the extensive Omega world coverage *without* lane resolution or identification to the same extent that aircraft or submarines using a three frequency receiver can take advantage of the system *with* lane resolution and identification, the range of coverage of the system not being related to the *number* of frequencies used.

53. The AN/ARN-99 (XN-1) receiver was the first automatic, [quantity-produced] three frequency Omega receiver approved for Navy operations. (This was the forerunner of the AN/ARN-99 three-frequency receiver.) The AN/ARN-99 [(XN-D)] (XN-1) was first installed and tested in an aircraft in June 1969. Subsequently, the AN/BRN-7 three-frequency receiver was developed for use in submarines by modifying the software in the ARN-99 to facilitate lane resolution while submerged.

The processing of the Omega signals in AN/ARN—99(V)1, ARN-99, and BRN-7 receivers is controlled by computer software. The AN/ARN-99(V)1 normally shares the use of a general purpose computer, used with other equipment aboard the craft or vessel, whereas the ARN-99 and BRN-7 receivers are provided with their own built-in computer.

ARN-99 and BRN-7 Omega receivers use a propagation model developed by Naval Electronics Laboratory and, thereby, are able to apply propagation corrections to incoming signals. They also select the optimum orientation of the loop antenna; compensate for the motion of the craft or vessel; compensate for the oblateness of the earth, and are able to provide a direct readout of position in terms of latitude and longitude.

[54. Decca lost a potential profit by virtue of defendant's preemption of Omega. That profit would have been at at least equal to the profit Decca would have made on a "turn key" sale of such a system to defendant. Taking first the system as it actually existed at the end of FY 1975, including relevant receivers, and using Decca's pricing methods and markups employed in the sale of its MK X systems, Decca estimates the total price of the system would have been about $129.7 million, of which Decca figures its profit would have been about $22 million. This figure does not take into consideration the facts that (a) the Decca MK X system was being sold in a competitive market, (b) defendant had an urgent military need for Omega, (c) Omega is unique; it is the only system which can reach submerged submarines, and (d) Omega presents a tremendous saving ($640 million) compared to the next best noninfringing alternative. Had those facts been taken into consideration, Decca estimates a lost profit of about $32 million.]

[55. Defendant's cost saving over a 10-year period, compared to the next best noninfringing system, LORAN-C, was expected to be approximatly $640 million, according to defendant's own computations and representations. (See Appendix A) Since Decca was both willing and able to build and operate the Omega system, had contributed materially to the relevant technology, and had demonstrated the feasibility of the system, an award of a magnitude such as the 20 percent of saving awarded in *Shearer* v. *United States*, 101 Ct. Cl. 96, 60 USPQ 414 (1944), or the 25 percent of the saving awarded in *Olsson* v. *United States*, 87 Ct. Cl. 642, 37 USPQ 767 (1938), would be justified. If the saving is amortized on the basis of $64 million per year for an eight transmitter system, or $32 million per year for a four transmitter system, 20 percent of that amount would be $6.4 million. Computing the saving from October 24, 1967 to July 22, 1975, the recovery would be approximately $49.6 million. Assuming further that the savings estimate was inflated by a 100 percent markup, discounting the $49.6 million per year figure by 50 percent leaves a realistic saving of $28.4 million over the October 24, 1967 to July 22, 1975 time period.]

[56. If the willing licensor-willing licensee approach is employed, the entire market value rule should be used in determining the base upon which a reasonable royalty should be computed. Due to the fact that defendant itself made the infringing system, defendant's out-of-pocket expenditures do not fairly represent the full market value of the system since it does not include normal G&A expense or a profit markup which would ordinarily be included in a full market value price. Therefore, many items beyond defendant's direct procurements must be included in arriving at the entire market value of the system and use thereof.]

[57. Based on Decca's calculations, including its projected profit and general and administrative expense, the total cost of an eight-transmitter system would be:

Prime Contractor role	$15,000,000
RDT&E	48,500,000
Sta Ops (O&M,N)	30,300,000
Installation	4,000,000
Construction	43,700,000
Electronics	11,900,000
Receivers	25,500,000
Total	$178,900,000]

[58. The royalty rates of Decca's prior licenses are not applicable to the system construction phases of the case at bar. Decca did not license system construction, and its licensees were not equipped to construct systems. In addition, prior to defendant's taking, no licenses were granted even for the components of Omega/Delrac-type systems. After defendant's taking, one license was granted to ITT for Omega/Delrac-type system components, but since defendant's taking was already in full progress, the rates of that license cannot be taken as a controlling expression of the full value for the present determination, even for components.]

[59. If compensation is to be based on a reasonable royalty applied to the full market value of the system as it existed from]

[October 24, 1967 to July 22, 1975, a royalty rate of 10 percent is adequate for the case at bar. This takes into account the importance of the patent in suit, the uniqueness of the Omega system which was made practical by its use of the patent in suit, and the vast cost saving ($640 million) as compared to the next best noninfringing alternative, LORAN-C.]

[60. Using a rate of 10 percent, and if Decca's proposed base of $178.9 million is used, a royalty of $17.89 million is found.]

[61. The figure of $17.89 million for a license is below the above-stated $22 million lost profit figure estimated by Decca for the sale of a complete system.]

[62. Although the figure of $17.89 million may be a reasonable royalty for defendant's *procurements*, the value to plaintiff of what was taken was substantially more than the mere value of a license covering those items.]

[63. Plaintiff did not grant licenses for complete systems under the patent in suit. Plaintiff licensed components, but habitually controlled the installation and operation of the entire system. Therefore, there is no controlling precedent for plaintiff's licensing the patent in suit for the sale of complete systems, and there is no controlling precedent prior to defendant's "taking" for licensing even the electronic components for the Delrac/Omega invention.]

[64. In the case at bar, defendant's saving by virtue of building the infringing system instead of the next-best noninfringing alternative, *i.e.*, LORAN-C, was unusually large (*i.e.*, $640 million), and at the same time defendant obtained thereby a system that could be used by continuously submerged submarines. By the precedent of *Marconi Wireless Telegraph Co.* v. *United States*, 99 Ct. Cl. 1, *aff'd in part and rev'd in part*, 320 U.S. 1 (1943), *Olsson*, *supra*, and *Shearer*, *supra*, Decca, in arm's-length negotiations could have justifiably bargained for a higher payment than the mere $17.89 million arrived at by the licensing approach based solely on the basis of cost saving.]

[65. Taking all of the above facts in summation, neither the "lost profits" basis, nor "royalty-licensing" approach of *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978), and *Tektronix* v. *United States*, 216 Ct. Cl. 144, 575 F.2d 832, 198 USPQ 378 (1978), fits the case at bar as well as the "savings to defendant" approach and, accordingly, a total basic award of approximately half of $49.6 million recovery figure as outlined above, namely $24.8 million, would constitute the basic reasonable and entire compensation for defendant's manufacture and use of Decca's patented system, exclusive of delay compensation.]

66. Eight Timing and Control Sets, AN/FRN-30, (item 1, finding of fact 47) were produced by the Naval Electronics Systems Command (NAVELEX) for the eight permanent Omega stations under contract N00039-70-C-0533 effective April 3, 1970 (hereinafter " '0533 contract") with the Litcom Division of Litton Systems, Inc. The final cost of these sets, exclusive of spare parts and cesium beam standards, was $2,158,341 or $269,793 each. In addition, a ninth timing and control set was procured under A00010 of that contract. The cost of this ninth timing and control set, exclusive of marking and packaging, is $212,738.68. [The total for this item, therefore, is $2,371,079.60.] However, the ninth set was never connected to an Omega transmitter to generate signals and, thus, was never part of the claimed combination.

The following is a tabulation by contract line item of the amounts obligated for each item ordered under the '0533 contract:

Item	*Description*	*Quantity*	*Total Extended Price*
0001	Omega Time & Control Set	8	$2,158,341.00
0001AA	Manuscript Submittal	lot	313,726.00
0002	Interim Repair Parts		
	Exhibit A	lot	279,418.26
	Exhibit B	lot	2,380.32
	Exhibit C	lot	16,662.24
0003	Maintenance Repair Parts		
	Exhibit B	lot	123,081.74
	Exhibit C	lot	215,412.68
0004	Data		Not separately priced

Item	*Description*	*Quantity*	*Total Extended Price*
0005	Instruction Manual	15 Sets	$ 24,300.00
0006	Conduct Course	2 courses	4,280.00
0007	Foreign Technical Services	44 mandays	1,412.50
0008	Technical Services Spares List B	31 mandays	6,082.37
0009	Support for items 6, 7, and 8	Est.	6,153.15
Contract Value			$3,151,250.26

67. The cesium beam standars used as components of the AN/FRN-30 timing and Control Set (item 1, finding of fact 47) to control the transmission cycle were separately procured from Hewlett-Packarad Company under contract N00060-70-C-0688, at a cost of $12,655.59 each. Twenty standards are sufficient for five of the eight permanent stations. The cesium beams for the remaining three would be taken from the four earlier established stations (Trinidad, Forrestport, Hawaii, and Norway).

68. Eight Omega Antenna Tuning Sets, AN/FRQ-18(V) (item 2, finding of fact 47) were procured under NAVELEX Contract N00039-71-C-0012 effective October 5, 1970 (hereinafter " '0012 contract) with Continental Electronics Manufacturing Company. The cost of the eight AN/FRQ18(V) tuning sets, along with the frames and Litz wire for the associated helix coils, exclusive of repair or spare parts, comes to a total of $2,928,848.60, or $366,106 each.

The following is a complete tabulation by contract line items of the amounts obligated for each item ordered under the '0012 contract:

Item	*Description*	*Quantity*	*Total Extended Price*
1	Omega Tuning Set, two reels of Litz wire, 960 Litz cable pads	4	$1,653,533.32
2	Omega Tuning Set, one reel of Litz cable, 576 Litz cable pads	4	1,275,315.28

Item	*Description*	*Quantity*	*Total Extended Price*
2A	Transportation Charge	lot	$ 1,380.00
3	Material Sample	1	No charge
4	Special Tools	8 sets	No charge
5	Interim Repair Parts Spares List A	8 sets	369,284.40
6	Interim Repair Parts,	1 set	73,983.00
7	Data Items		Not separately priced
8	Interim Repair Parts, List A005	8 sets	86,717.52
9	Maintenance Repair Parts, List A002	1 lot	130,418.48
10	Technical Services Domestic	150 mandays	24,600.00
11	Support at actual cost	Est.	70,453.00
12	Technical Services Foreign	45 mandays	8,640.00
13	Support at actual cost	Est.	28,300.00
14	Repack MILVAN	1 job	29,350.00
Contract Value			$3,875,979.00

69. Eight Omega Transmitter Sets, AN/FRT-88 (item 3, finding of fact 47), were procured under NAVELEX contract N00039-69-C-0560 effective May 9, 1969 (hereinafter " '0560 contract") with Litcom Division of Litton Industries, Inc. These eight sets, each containing two transmitter groups, were procured at a cost of $2,413,878 or $301,735 each.

The following is a tabulation by contract line item of the amounts obligted for each item ordered under the '0560 contract:

Item	*Description*	*Quantity*	*Unit Price*	*Total Price*
1	VLF Omega Transmitter AN/FRN-88	6 sets	$296,999.67	$1,781,998.00
2	Equipment Repair Parts 1 & 10	6 sets		
	Exhibit A		214,500.00	313,552.00
	Exhibit B		69,000.00	
	Exhibit C		30,052.00	
3	Maintenance	1 lot		
	Repair Parts Items 1 & 10 Exhibit D		$195,994.00	$195,944.00

Item	*Description*	*Quantity*	*Unit Price*	*Total Price*
4	Data Items	(included in Item 1)		Not separately priced
5AA	Prepare and Furnish Instruction Material			11,748.00
AB	Conduct Course	10 mandays	$	$ 2,090.00
AC	Travel & Subsistence for AB			1,564.62
6	Deleted			
7	Deleted			
8	Services—Domestic			6,451.00
9	Subsistence & Travel			6,700.00
10	VLF Omega Transmitter AN/FRN-88	2 sets	315,940.00	631,880.00
11	Equipment Repair Parts, Item 10			63,207.00
Contract Value				$3,015,134.00

70. The procurement of each Omega station includes Government-Furnished Equipment (GFE) costing $11,500 and consists of: two AN/USM-281A oscilloscopes ($2,000 each), two Model 1123-9811 G.R. digital synchrometers ($1,500 each), and three Model 16 Minneapolis-Honeywell recorders ($1,500 each).

According to defendant's calculations of the total cost of each station, the estimated cost of the in-place spares, such as one of the four cesium beams; one transmitter group; one variometer assembly, and two oscilloscopes which were mounted in place so employees would not remove them from the station, is $269,159. The cost of adding components for generating and transmitting FT_1 and FT_2 was estimated as $108,279. The estimated per station cost of the monitor receiver and display equipment in racks 7 and 8 of the AN/FRN-30 was $54,752. These items (totaling $432,190), however, are not excludable from the computation of the cost of the necessary station electronics for Omega transmission.

71. Six of the permanent Omega stations use or will use a top-loaded monopole antenna similar to the antenna at the station located at LaMoure, North Dakota. The stations at Nor-

way and Hawaii use a valley-span antenna. The top-loaded monopole is a common type of antenna and the valley-span is an acceptable alternative, although less common. Each antenna was individually designed for its particular location and would not have been installed nor would use thereof be continued except to sustain the Omega system. The VLF communications stations in the Omega System utilize antennae tuned by helix coils, as well as transmitters to amplify and apply signals to the helix coils. The helix coils and amplifiers, therefore, are essential components of the system covered by the claimed combination. Hence, their market value is dependent upon use of the invention claimed in the patent in suit.

72. While the Omega system transmits three Omega frequencies, most military Omega navigation receivers utilize only the 10.2 kHz signal for operational purposes after initialization by use of the three frequency mode. [Use of those receivers, in combination with Omega transmitters, constitutes infringement of the claims of '816 in suit since they have no utility unless they are initialized by use of the Omega system, *i.e.*, they receive and utilize the Omega frequency format transmitted from the Omega stations.]

Mr. Fletcher, an electronics engineer, who had been involved with Omega since October 1965, estimated the cost of the station electronics for a station generating and radiating a 10.2 kHz signal, alone, at $522,466. He estimated the cost of adding the 11 ⅓ and 13.6 kHz signals used for initialization and lane resolution in ARN/-99 and BRN-7 receivers as $108,279 per station. His calculations were based, however, on estimates rather than actual procurement costs.

73. The cost of designing and constructing complete Omega *stations* includes the cost of items such as land, buildings for equipment, personnel, roads, prime power equipment, and diesel backup generators. The named items, however, are not part of the claimed invention of '816, nor are they items which must be specially created to utilize the '816 invention. The

building used to house the helix, however, is specially designed and constructed for use in the infringing system. Accordingly, that part of the cost of designing and constructing the Omega stations attributable to design and construction of land, buildings for equipment (except the helix building) and personnel, road, prime power equipment, and diesel backup generators are excluded from computation of the base.

74. Plaintiff, through its American subsidiary, Decca Navigation Systems, Inc., by an agreement dated November 9, 1961, licensed Bendix Corporation to manufacture, have manufactured, sell and/or use [and sell] transmitters and receivers for [use in connection with] plaintiff's *Decca Navigator Systems* and *Dectra Systems*. Plaintiff handled the problem of ancillary equipment and expenses involved in the construction of stations in which the transmitters would be installed by incorporating within the Bendix license the following definition of transmitters:

> 'Transmitter' shall mean all of the technical equipment used in the production of satisfactory and reliable Decca or Dectra service from, but not including, the primary power supply to, and including, the dispatch of the service, but shall not include land, building[s], vehicles, diesels, real property improvements and the primary power supply.

Defendant's expert witnesses summarized the cost of design and construction of Omega stations and apportioned it in accordance with this definition of transmitter.

In making these apportionments, items such as administration or supervision were treated by defendant as overhead, since they were applicable to all tasks, and were apportioned to the "transmitter" and "non-transmitter" or other categories in proportion to their dollar values.

75. It was estimated by witnesses that the cost of designing the antennas for the permanent Omega stations was between $150,000 to $200,000 for the architectural portion and $50,000 to $100,000 for the electrical portion per station. Thus, total

[Item	Cost of Installation	Cost of Components	Total Cost As Installed
Basic 10.2 kHz	$330,127.30	$ 522,466	$ 852,593
11 ⅓ and 13.6 add-on	19,569.64	108,279	127,849
Subtotal	$349,696.94	$ 630,745	$ 980,442
FT_1 and FT_2 add-on	19,569.64	108,279	127,849
Subtotal	$369,266.58	$ 739,024	$1,108,291
Spares add-on	$ 35,739.33	$ 269,159	$ 304,898
Subtotal	$405,005.91	$1,008,183	$1,413,189
Monitor add-on	2,294.09	53,252	55,546
TOTAL	$407,300.00	$1,061,435	$1,468,735]

79. The costs of design and construction of the North Dakota station, *if* apportioned in accordance with a reasonable interpretation of the definition of transmitter appearing in the Bendix license are as follows:

ITEM	COST
Construction	
Transmitter[3]	$2,991,939
All other Costs:	
Helix Building	336,822
Transmitter Building	464,008
General Purpose Building	515,262
Site Work (roads, utilities, minor structures, etc.)	977,425
In-House and other procurement	16,496
Supervisory, Inspection & Overhead (SIOH)	142,351
TOTAL	$5,444,303

[3] Includes an apportioned amount of SIOH and $186,100 for the total cost of procurement and installation of electronic shielding in the helix building. In addition, transmitter includes the antenna, and associated structure as set forth in DA 28.

antenna design costs ranged between $200,000 and $300,000 for all eight stations.

76. The Omega station at LaMoure, North Dakota was first declared operational on October 1, 1972, a little less than 3 years prior to expiration of the '816 patent. A three frequency Omega format consisting of 10.2, 11 ⅓, and 13.6 kHz signals was radiated from the LaMoure station at all times when the station was in operation.

77. The parties stipulated that the following expenses reflect the cost of installing station electronics and interconnecting them to the antenna in the North Dakota station:

ITEM[2]	COST
ON-SITE INSTALLATION	
Engineering	$ 43,300
Mechanics	137,000
Contract	9,200
MISCELLANEOUS SUPPORT	
Management & Supply	23,500
Engineering & Drafting	86,100
Technical Support	23,600
MATERIALS	84,600
TOTAL	$407,300

The cost of station electronics for permanent stations is at least $1,275,165 per station. With the addition of the installation costs, the total cost of the North Dakota station is $1,682,465. This figure includes the cost of installed station electronics capable of radiating only a 10.2 kHz signal.

[78. The following figures represent defendant's computation of the cost of the North Dakota station as modified to operate in the Omega format:]

[2] All labor charges have been increased by approximately 30 percent to take into account leave and fringe benefits. Items include travel and per diem expenses where incurred.

ITEM	COST
DESIGN[4]	
Transmitter	$283,668
All other Costs	399,225
TOTAL	$682,923

Combining the apportioned figures relating solely to the transmitter construction *and* design results in a total cost for the construction and design of just the "transmitter" portion of the station (including antenna) of $3,275,607. ($2,991,939 (construction) plus $283,668 (design)).

80. The Haiku, Hawaii station is located in a former World War II communications station. In 1962, the Haiku station was operated with a station in Balboa using a master-slave transmission mode rather than the cesium beam synchronization used in Omega. At that time, it was a Naval communications facility and was used in early Omega research for communications. The station at that time contained an FRA-31 transmitter (having only one transmitter group). The FRA-31 was the antecedent of the FRT-88 transmitter installed in the permanent Omega stations.

The original Hawaii station was modified for three-frequency capability in May 1967, and was further modified in June 1967. Transmission in the three frequency mode from the original station was suspended on February 15, 1973.

81. Construction of a permanent Omega station at Hawaii began in November 1972 and continued until May 1974. The station checkout began in June 1974.

From June through September 1974, the permanent station radiated test transmissions which were of low power. Damage to the antenna during a heat and corona test at 9.8 kHz, on June 17, 1974 delayed radiation of higher power transmissions. Accordingly, shortening of the helix coil for the permanent station

[4] DA 40 contains a line marked "Other transmitter" which denotes expenses which are allocable to transmitter designs which were not used in the station configuration or services that were incurred after the station became operational.

to enable tuning at 10.2 kHz was not accomplished until July 2, 1974. The station transmitted intermittently throughout the period from June 1974 through January 1975, when it resumed transmission at reduced power. The Hawaii station was declared fully operational in the three frequency mode in January 1975, approximately 6 months prior to expiration of the '816 patent.

82. The parties stipulated that the following expenses reflect the cost of installing station electronics in the permanent Hawaii station:

ITEM[5]	COST
ON-SITE INSTALLATION	
Engineering	$ 36,700
Mechanics	167,700
Contract	66,000
MISCELLANEOUS SUPPORT	
Management & Supply	53,400
Engineering & Drafting	63,800
Technical Support	54,300
MATERIALS	68,000
TOTAL	$509,900

83. Combining the cost of installation with the cost of station electronics for permanent stations, which is $1,275,164.58, results in a total cost of $1,785,064.58 for the station electronics as installed in Hawaii.

84. The costs of design and construction of the Hawaii station, if apportioned in accordance with a reasonable interpretation of the Bendix license, are as follows:

[5] Labor increased by approximately 30 percent for leave and fringe benefits. Items include travel and per diem expenses where incurred.

ITEM	COST
CONSTRUCTION	
TRANSMITTER[6]	$3,234,310
All Other Costs	
Helix Building	$ 301,960
Transmitter Building	407,546
Site Work (roads, utilities, minor structures)	223,682
In-house and other procurement	9,335
Supervisory, Inspection & Overhead (SIOH)	58,850
TOTAL	$4,235,693
DESIGN	
Transmitter	361,446
All Other Costs	140,534
TOTAL	$ 501,980

85. Thus, the cost of design and construction of only the "transmitter" portion of the Hawaii station including the antenna was approximately $3,595,756 ($3,234,310 for construction, $361,446 for design).

86. During the course of implementing the Omega system, a small experimental VLF station was established at Novik, Norway, in 1965. A permanent Omega station was established, however, at Aldra (near Bratland), Norway. The Novik installation was established to determine the feasibility of a valley-span antenna. Omega signals were never satisfactorily radiated from that installation. The station at Aldra, installed in March 1966, consisted of an FRA-31 transmitter, timing and tuning equipment, and a helix coil, all mounted on flatbed trailers. The helix coil was originally housed in an inflatable dome, and later in a rigid structure, neither of which contained shielding. The station was modified for three frequency

[6] Includes apportioned part of SIOH and the $177,880 estimated cost of shielding for the helix building.

capability in May 1967. However, because of a fire in the helix house in the fall of 1970, the Aldra station lost its capability to transmit the 11 ⅓ kHz signal for a time. From that time until August 1973, only 10.2 and 13.6 kHz signals were radiated from the station. The station discontinued transmission until the permanent station was declared operational again on December 20, 1973.

87. The antenna used at Aldra was, at all times, a valley-span antenna with two spans extended from Bratland, across a fiord, to an off-shore island. The spans thus formed a V-shape with the common point being the island. The spans were constructed prior to May 1967 when modification of the station for three frequency capability was completed.

88. The parties stipulated that the following expenses reflect the cost of installing station electronics in the permanent Norway station:

ITEM[7]	COST
ON-SITE INSTALLATION	
Engineering	$ 37,900
Mechanics	49,200
Contract	0
MISCELLANEOUS SUPPORT	
Management & Supply	51,600
Engineering & Drafting	40,100
Technical Support	14,300
MATERIALS	76,800
TOTAL	$269,900

89. Combining the cost of installation with the cost of permanent station electronics, which is $1,275,164.68, results in a total cost of $1,545,064.58 for installed station electronics.

90. The costs of design and construction for the permanent Norway station, apportioned in accordance with a reasonable interpretation of the Bendix license, are as follows:

[7] Labor increased by approximately 30 percent for leave and fringe benefits. Items include travel and per diem expenses where incurred.

ITEM	COST
CONSTRUCTION	
Transmitter[8]	$1,913,214
All Other Costs:	
Helix Building	152,577
Transmitter Building	335,963
Site Work (roads, utilities, minor structures)	604,427
In-house and other procurement	6,748
Supervision, Inspection & Overhead (SIOH)	64,741
TOTAL	$3,077,670
DESIGN	
Transmitter	232,770
All Other Costs	91,447
TOTAL	$ 324,217

Thus, the total cost of design and construction of the "transmitter" portion of the station (including the antenna) is $2,145,984 ($1,913,214 for construction, $232,770 for design).

Adding to this the installed cost of all station electronics at the Norway station ($1,545,064.58) results in a total cost of $3,691,048.58, [exclusive] inclusive of the installed costs for FT_1 and FT_2 capability, in-place spares, and monitor.

91. The station at Japan is located at Tsushima. It is generally similar to the station at LaMoure, North Dakota.

92. Installation of the Transmitter and Timing & Control equipment at the Japanese station commenced in April 1973. Installation and site construction continued until mid-December 1974 when the station checkout commenced. The station was unable to radiate useable 10.2, 11 ⅓, and 13.6 kHz signals until after the power tests were concluded and the helix coil shortened to tune the antenna for 10.2 kHz transmissions. The station com-

[8] Includes an apportioned amount of SIOH and $172,596 for a total cost of shielding for helix building.

menced transmission under low power tests at 9.8 kHz at the end of February 1975, and was declared fully operational on April 30, 1975, a few months prior to expiration of the '816 patent.

93. Japan stood to benefit from the construction of the Omega station and use of the Omega system, and agreed to bear a large portion of the costs of the station in Japan. The agreement with the Government of Japan required the United States to supply the station electronics for the station, but provided that the Japanese Government would construct, operate, and maintain the station. The cost to the United States of installing the station electronics in the Japanese station was $113,200. In addition, the United States provided the entrance bushing for the helix house at a cost of $10,940; performed design services related to the Japanese station having a value of $75,600.83; provided for installation and contributed to the cost of materials in the amount of $36,600; and provided engineering, management, drafting and technical support services at a cost of $76,600. The total cost of the contribution by the United States to the design, fabrication, construction, and electronics installation at the Omega station at Tsushima, Japan, was:

ITEM	COST
Station Electronics	$1,275,164.58
Installation	113,200.00
Entrance Bushing	10,940.00
Design and Engineering	75,601.00
Installation Materials	36,600.00
Technical Support	76,600.00
TOTAL	$1,588,105.58

94. The Omega stations at Argentina, Liberia, and La-Reunion were not operational in time to transmit Omega signals prior to expiration of the '816 patent on July 22, 1975. As of that date, the helix coils, although installed, had not been tapped at any of these stations. [Otherwise, they were] But for this fact, the stations would have been capable of operation in the three frequency mode.

95. The tapping of the helix coil for the Argentina station began on August 26, 1977, and the station was not finally tested until September 19, 1977. As of July 22, 1975, the resonant frequency and static capacity of the antenna at Liberia had not been finally measured, nor had the helix taps been calculated, or made. At the LaReunion station, the erection crane was still attached to the tower, the helix frame was erected but no wire had been wound on the frame, the helix tap locations had been calculated and the plate transformer for one of the transmitters was still in transit to the site as of July 22, 1975.

96. The necessary station electronics for the Omega stations in Argentina, Liberia, and LaReunion, although [available for use in combination with ARN-99 and BRN-7 receivers] in the possession of defendant prior to the expiration of '816, were not operational by that date.

97. Although all of the station electronics for the Australia station were under procurement or delivered to defendant prior to July 22, 1975, funds for construction of the Australia station were not available until July 1, 1975, since they were not provided until the FY 1976 budget. Thus, the Omega station was not operational in the three frequency mode during the term of the '816 patent.

98. The station electronics used at the so-called "interim stations" at Hawaii, Forrestport, Trinidad, and Norway, before being declared fully operational, differed only slightly from the station electronics used or planned to be used in the permanent, fully-operational Omega stations. The Hawaii, Trinidad, and Forrestport stations originally used an AN/FRA-31 transmitter, rather than the AN/FRT-88 transmitter. This transmitter contained only one transmitter group and, thus, no in-place spare transmitter groups were used at the stations equipped with the AN/FRA-31 transmitters. Up to the present time, the Trinidad station was only one transmitter group with no in-place spare. The transmitter originally used at the Norway station was built by Naval Electronics Laboratory (NEL). Hence, the market value of that transmitter is difficult, if not impossible, to ascertain.

99. The parties stipulated, however, that the costs of designing, developing, fabricating, and installing station electronics at the stations at Hawaii, Forrestport, Trinidad, and Norway, prior to installation and operation of the Omega system (stations radiating only a 10.2 kHz signal and the additional cost for 11 ⅓ and 13.6 kHz signals), were:

	Hawaii	*Forrestport*	*Trinidad*	*Norway*
Cost of basic 10.2 kHz station	$488,901	$546,751	$585,256	$496,540
Cost of adding 11 ⅓, 13.6 kHz	73,400	73,400	73,400	73,400
TOTAL	$562,301	$620,151	$658,656	$569,940
GRAND TOTAL	$2,411,048			

The above figures include charges for machine shop support, installation, travel and per diem, freight, and design and development in the following amounts:

	Hawaii	*Forrestport*	*Trinidad*	*Norway*
Support Services (labor/overhead)	$10,000	$10,000	$11,000	$13,500
Installation	9,850	9,850	12,100	7,950
Travel & per Diem	5,550	6,350	9,650	9,850
Freight & Shipping	1,800	5,200	3,000	10,000
Engineering Mft., Design & Development	52,200	52,200	52,200	52,200

100. The Trinidad "interim station" was located at the site of a World War II LF communications station. It was employed as a replacement for the single frequency at Balboa, Panama Canal Zone (which was a communications station the Omega project had been allowed to use for research). Construction to renovate the Trinidad station so that it would be useable in the Omega project began in late 1965 and was completed in February 1966.[9]

[9] While the exact site for the permanent Trinidad station had not been selected until 1965, planning for interim stations, such as Trinidad, began in 1963.

When installation was completed and the station became fully operational on February 16, 1966, the Trinidad station transmitted a three frequency (10.2, 11 ⅓, and 13.6 kHz) format. It was also capable of broadcasting just 10.2 and 13.6 kHz signals, if desired, when it became fully operational by February 16, 1966.

101. The original LF communications equipment at Trinidad included two valley-spans forming a valley-span antenna, and buildings for sheltering a transmitter and helix. The total cost of design and construction to adapt the Trinidad station to the Omega System was $1,427,529. Of this, about $386,492 was the cost of the antenna (design and construction).[10]

The $1,427,529 also included $17,992 in construction and installation spares, and $569,836 in expenses for buildings, roads, prime power, and other unspecified excludable items. Thus, the cost for adapting the Trinidad station (exclusive of station electronics) to the Omega system, in accordance with defendant's interpretation of the Bendix license, is $839,701.

102. The Trinidad station contains an FRA-31 Transmitter Group (which has only one transmitter, rather than an FRT-88 Transmitter Group which contains two transmitters) and also contains only three (rather than four) cesium beams. The total cost of the Trinidad Omega station electronics, including installation cost, design and development is $658,656. Thus, the total cost allocable to "transmitter" and incurred in establishing an Omega station at Trinidad was $1,498,357. ($839,701 plus $658,656).

103. The Trinidad station remained in operation along with the permanant stations at North Dakota, Hawaii, Norway, and Japan up to and beyond July 22, 1975, despite the fact that it was not equipped with a spare transmitter, had only three rather than four cesium beams, and lacked some redundant parts with which the other permanent stations are equipped.

104. The interim station at Norway was installed in March 1966 with a checkout of the station lasting from March through April 1966. The station initially transmitted only on a two fre-

[10] Total of lines 1a, 2a, 3a, 4a, 6, 7, 8, and 11 of DA 41.

quency mode. However, its station electronics were modified by February 1967 to provide a three frequency capability and transmission in that mode was effected by that date.

105. The total cost of constructing the interim Norway station was $1,905,717. This includes $107,000 which was the cost of erecting a test span at Novik, Norway, which never radiated a three frequency format. Of the total, $4,675 was for construction spares and $781,259 was excludable either under defendant's interpretation of the Bendix license definition of "transmitter" or as pertaining to the Novik test span. Thus, the cost of constructing and designing the Norway station allocable in accord with defendant's interpretation of the license definition of "transmitter" was $1,119,783. Including $569,940 for the installed station electronics yields a total allocable cost of $1,689,723.

106. The interim station at Haiku, Hawaii, was located at a former communications station. The only significant cost of adapting that communications station to an Omega station was the cost of installing the station electronics. Thus, the cost of adapting the Hawaii station to the Omega station was $562,301.

107. The station at Forrestport, New York, was located at an Air Force communications station which already had a 1,200-foot tower. A helix house was built at a cost of $30,000 (including shielding). While the Forrestport station had been used for Omega experiments as early as 1962, it did not acquire a two frequency capability until 1965. It was not equipped to transmit the three Omega frequencies (along with FT_1 and FT_2) until June 1967. In 1973, when the North Dakota station became operational, the Forrestport station reverted back to the Air Force.

108. The cost of adapting the Forrestport station for use as an Omega station was $30,000 for the helix house, plus $620,151 for station electronics, including installation, for a total of $650,151.

109. Two AN/ARN-99(XN-1) receivers (which were designed and developed by Northrop) were the first automatic three frequency Omega purchased by defendant from a manufacturer. No automatic three frequency receivers useable in the Omega system had been manufactured previously by a commercial supplier.

The two AN/ARN-99 (XN-1) receivers were procured under Naval Air Systems command (NAVAIR) contract N00019-68-C-0355 (dated February 29, 1968) with Electronics Division, Northrop Corporation. The contract was negotiated under the authority of 10 U.S.C. § 2304(a)(11). An option to procure two additional receivers, designated AN/ARN-99 (XN-2), was exercised under P006 in July 1969.

A cost proposal submitted by the Nortronics Division of Northrop contained a detailed estaimate of the cost of various tasks which were eventually performed under the '0355 contract. Task 1.3 estimated a cost of $358,318 for materials, fabrication, assembly, inspection, in-line testing, and functional acceptance testing of two receivers, Task 5.0 called for the materials, fabrication, assembly, inspection, and acceptance testing of the two receivers. This was estimated to cost $197,430. However, the '0355 contract, while encompassing the tasks set out in Northrop's cost proposal, did not specify these tasks with the same precision. The contract incorporated the proposal by reference at page 4. Thus, the actual manufacturing cost of the ARN-99(XN) receivers included items such as engineering services and data.

Northrop's cost proposal is indicative of the price which Northrop would ask for the ARN-99(XN-1) and (XN-2) receivers.

110. The following table indicates the line items procured under the '0355 contract, along with the prices paid for them:

Item	*Description*	*Estimated Cost*	*Total Cost*
1	(2) Engineering models and spares	$ 939,670.00	$1,188,619.00
1AA	Long lead time items for Phase II		Not Separately Priced
1AB	Repair and Maintenance services for item 1	17,777.50	19,373.00
1AC	Design data for item 1		Not Separately
1AD	Field Engineering for item 1 (1 man-year)	5,076.00	5,533.00
1AE	Qualification test of Omega Receiver/Buffer	86,116.00	93,866.00

Item	*Description*	*Estimated Cost*	*Total Cost*
2	(2) Service test models and parts	$ 414,246.00	$ 565,125.00
2AA	Design of special support equipment for item 2		Not separately priced
2AB	Design data for item 2		Not separately priced
2AC	Engineering Services for 2 man-years		Not separately priced
2AD	Provide repair and maintenance services for item 2	16,320.00	17,788.00
2AE	Provide training in maintenance and operation of item 2	7,336.00	7,996.00
2AF	Transportation for engineering under item 2AC	3,800.00	4,142.00
3	(1) model special test equipment and spares		Not Ordered
4	Design data for item 3		Not Ordered
5	Fabricate and test one Receiver/Buffer	37,375.00	90,739.00
5AA	Services necessary for repair and maintenance of item 5	9,174.50	10,000.00
5AB	Design data for item 5		Not Separately Priced
5AC	Field engineering for item 5	31,765.00	34,623.00
6	Ground support equipment for items 2 and 5	56,881.00	62,000.00
TOTAL		$1,625,537.00	$2,099,804.00

111. A total of 95 AN/ARN-99(V)1 receivers were ordered under NAVAIR contract N00019-72-C-0329, dated December 30, 1971, under line items 0001, 0023, and 0027. The ARN-99(V)1 receiver set consists of the following components: an OR-901 ARN-99(V) Receiver Converter; an AS-2623A/ARN-99(V) Antenna-Coupler; and an MT-4532/ARN-99(V) Mounting Base.

These sets include neither a computer nor a Control-Indicator. The average cost of each of these sets is approximately $22,444.72.[11]

Of the 95 receivers procured under the '0329 contract, a total of 31 were manufactured for, but not accepted, by the United States until after July 22, 1975. This included 24 receiver sets procured under line item 0023, 3 sets procured under line item 0001AB, and 4 sets procured under line item 0001AC in which the receiver-converters were disassembled into modules. Fourteen of the 95 AN/ARN-99(V)1 sets were assembled and installed in aircraft prior to July 22, 1975.

The '0329 contract called for delivery of the 24 receiver sets under line item 0023 after July 22, 1975. The line item of the 31 AN/ARN-99(V)1 sets under items 1AB, 1AC, and 23, undelivered as of July 22, 1975, is $690,735.52.

112. The following is a tabulation of the various line items and their respective prices under the '0329 contract for [165] 95 receivers ordered prior to July 22, 1975:

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0001	ARN-99(V)1 set	70	$22,319.23	$1,562,346.36
0001AA[12]	"	22	32.28	710.16
0001AB[12]	"	11	12.27	134.97
0001AC[12]	"	37	32.28	1,194.36
0002	Reliability testing for item 0001	lot	—	435,337.00
0003	First article approval testing for item 0001	lot	—	218,766.00
0004	Engineering drawings, lists, microcards	lot	—	12,816.00
0005	First article test report	—	—	Not separately priced

[11] Based on prices for items 0001 (including additions under item 0001AA, AB, AC), 0023, and 0027 as shown in finding 112.

[12] Line items AA, AB, and AC are part of item 1, broken down as per funding source. The figures under unit price and total price are additions to the basic price of line item 1.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0006	Technical manuals	lot	—	$ 23,444.00
0009	Provisioning data	lot	—	16,085.00
0014	Maintainability program	lot	—	35,155.00
0015	Technical Data	lot	—	223,900.00
0017	Administrative/ financial data	—	—	Not separately Priced
0018	Integrated Logistic Support	lot	—	99,310.00
0019	Data for item 0018	—	—	Not Separately Priced
0020	Maintenance engineering analysis program	lot	—	22,058.00
0022	Reuseable container for AN/ARN-99(V)	50	417.49	2,734.50
0023	AN/ARN-99(V)1 set	24	22,263.96	534,335.04
0027	AN/ARN-99(V)1 set	1	33,527.46	33,527.46
0028	Associate contractor services	500 hrs.	44.56	22,280.00
0029[13]	Repair services	lot	—	—
0030[14]	Shipping and storage containers for ARN-99(V)1	27	81.481	2,199.96[14]
0031[15]	AN/ARN-99(V) system safety program	lot	—	[15]
0032[15]	Data for item 0031	—	—	Not Separately Priced

[13] Under A00022, signed April 21, 1975, $1,500 was obligated for line item 29. The repair services were never required and, hence, this was deobligated by the Administrative Contracting Officer.

[14] The shipping cartons ordered under P00017, signed June 27, 1975 were not deliverable until October 1, 1975. Their price was $2,199.96.

[15] Not ordered until September 24, 1975, under P00018. This price was $14,100.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0033[16]	Disassemble AN/ ARN-00(V) sets to module level and repackage	lot	—	——[16]
TOTAL				$3,246,333.81

113. A total of 20 AN/ARN-99(V)4 Omega receivers were procured under NAVAIR contract N00019-74-C-0372, dated February 11, 1974 with the Electronics Division of Northrop Corporation. The AN/ARN-99(V)4 receiver sets consisted of the following components:

(1) OR-133(V)2/URN Receiver-Computer (P.N. 61710600-602A)
(2) AS-2623A/ARN-99(V) Antenna Coupler (P.N. 60710900-601B)
(3) MT-4538/ARN-99(V) Mounting Base (P.N. 61717020-601A)
(4) ID-1776/ARN-99(V) Control Indicator (P.N. 61710450-605A).

Of the 20 receiver sets procured under the '0372 contract, 18 sets were delivered to the United States prior to the expiration of '816. The cost of the two ARN-[00(V)] 99(V)4 sets procured under the '0372 contract, which were not delivered until after July 22, 1975, is $60,399.25 per set or $120,798.50. Only two of the 20 AN/ARN-99(V)4 receivers procured were assembled and installed in aircraft prior to July 22, 1975.

114. The following is a tabulation of the line items procured under the '0372 contract, along with their respective prices:

[16] Not ordered until May 10, 1976 under P00020. This price was $3,625.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0001	AN/ARN-99(V) 4 Navigational Set	20	$60,399.25	$1,207,985.00[17]
0002	Reuseable container for AN/ARN-99(V)4	20	85.00	1,700.00
0003	Reliability tests	20	10,477.00	209,540.00
0004	Technical data for item 0001	lot	—	92,448.00
0005	Technical manuals	—	—	21,600.00[18]
0006	Spare and repair parts for item 0001 (provisioned item)	.	—	23,444.00[19]
0008	Provisioning Technical data for item 0007	—	—	20,000.00
0009	Ground support equipment	—	—	16,085.00[20]
0010	Data for ground support equipment	—	—	18,740.00[21]
0016	Administrative provisional data	—	—	Not Separately Priced
0020	Computer programming documentation	—	—	116,359.00
0023	Spare and repair parts (item 0009)	—	—	[22]
0025	Integrated logistics support plan	—	—	95,760.00
0026	First article approval testing	lot	—	47,127.00
0027	First article test report	lot	—	12,026.00
0028	Operational logistic support plan	—	—	63,270.00

[17] Includes $12,185 definitized by A00022.
[18] An additional $252,231 was first obligated after July 22, 1975.
[19] An additional $145,736 was first obligated after July 22, 1975.
[20] An additional $328,758 was first obligated after July 22, 1975.
[21] An additional $16,300 was first obligated after July 22, 1975.
[22] The entire $20,000 was first obligated after July 22, 1975.

Item	*Description*	*Qty.*	*Unit Price*	*Total Price*
0029	Maintenance engineering analysis for peculiar ground support equipment	—	—	13,470.00
0033	Verification of interim level test equipment	—	—	7,500.00
TOTAL obligated prior to July 22, 1975				$1,967,054.00
TOTAL obligated after July 22, 1975				763,025.00
GROSS				$1,204,029.00

115. Under NAVAIR letter contract N00019-C-0268, dated January 3, 1975, the United States ordered 21 ARN-99(V)1 receivers and 8 ARN-99(V)4 receivers. This letter contract was superseded by Modification P2002, dated October 23, 1975. Both the original letter contract and the modification called for deliveries to commence in October 1975. This delivery schedule was not modified to provide for earlier deliveries. Thus, none of the line items of the '0268 contract were delivered to the United States prior to July 22, 1975. There is no evidence that any receivers under the '0268 contract were manufactured prior to July 22, 1975.

That contract called for the following unit prices for the following items:

OR-90/ARN-00(v) Receiver-Converter	$15,653
OR-133(V)2/URN Receiver-Computer	50,258
AS-2623A/ARN-99(V) Antenna-Coupler	1,516
MT-4534/ARN-99(V) Mounting Base	353
ID-1776/ARN-99(V) Control Indicator	8,813
	$76,593

116. NAVELEX entered into contract N0039-71-C-0126, effective February 26, 1971, with the Electronics Division of Northrop Corporation to develop software to adapt the ARN-99 (XN-1) to submarine use. This model was designated BRN-7. In designing the BRN-7 receiver (a three frequency Omega receiver

used aboard certain kinds of attack submarines) one of the two AN/ARN-99(XN-1) receivers previously procured was loaned to NAVELEX and adapted for submarine use. No hardware was procured under this contract; rather, the following items were supplied:

Item	*Description*	*Total Price*
0001	Modification kit (software) for AN/ARN-99 Omega receiver	$146,269.17[23]
0002	Data requirements	Not Separately Priced
0003	Factory training for four technicians in operation maintenance of (modified) AN/ARN-99	Not Separately Priced[24]

117. Under NAVELEX contract N00039-73-C-0209, accepted September 1, 1972, definitized by PZ0007, effective August 16, 1972, with the Electronics Division, Northrop Corporation, the United states ordered a total of 97 AN/BRN-7 receivers. This contract was the only production contract awarded prior to July 22, 1975 for the BRN-7 receivers. Of the 97 sets ordered, one under line item 0034 was purchased for the Government of France. Two other sets were not scheduled for delivery nor delivered until after the patent had expired. The average of ceiling prices of the 97 sets procured by the Government under line items 0002, 0020, 0034, and 0044 during the term of the patent was $53,002.04 per set for a total of $5,141,197.88. Of the 97 BRN-7 sets, 18 were installed prior to July 22, 1975.

An AN/BRN-7 receiver consists of the following components:

(1) Receiver Computer, OR-133/V/URN (P.N. 61710600-601A)
(2) Control Indicator, C-9461/BRN-7 (P.N. 61710450-602A)
(3) Interface Box, ON-128/WRN (P.N. 61716000-601A)
(4) Mounting Bases, MT-4610/WRN, MT-4611/WRN (P.N. 61717000-601A, 61718000-601A)
(5) Interconnecting cables, connectors, caps.

[23] *See* P00002, p. 2.
[24] *See* P00003, p. 1-2.

118. Four BRN-7 receivers were ordered as first articles, with first article testing to be performed by the contractor, under line item 0001 at a target cost of $407,710 each, the total target cost for the testing of the four items being $1,630,840. A ceiling cost of $1,797,037 was established in the contract.[25] These four sets were delivered to the Government under line item 0001. The Government returned the four first article items to the contractor, who [reconstructed] refurbished them and delivered the refurbished [reconstructed] items to the Government under line item 20 at a price of approximately $53,000 per receiver. The four first articles were not tested in combination with signals transmitted by Omega stations.

119. The following is a tabulation of the line items ordered under the '0209 contract:

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0001	First article BRN-7 receiver sets	4	$407,710	$1,797,037
0002	AN/BRN-7 receiver sets	35	48,100	1,855,070
0003	Interim repair parts	lot	—	1,165,000[26]
0004	First article program controller	4	117,947	519,867
0005	Program Controller	35	13,208	509,377
0007	Data (Exhibit A)	lot	407,729	449,280
0008	Instructional material	lot	18,511	20,397
0009	Instructional services	20 man-days	237.25	5,230
0010	Support for item 0009	lot	Est.	3,319[27]
0011	Data (Exhibit B)	lot	475	523
0012	Technical professional engineering services	167 man-days	243	40,581[27]
0013	Support for item 0012	lot	Est.	4,700[27]

[25] Ceiling prices will be treated as applicable for the '0209 contract, as 90 percent of the items under the '0209 contract are presently at ceiling price.

[26] Amount obligated as of July 22, 1975 following deobligation of $5,000 per modification A00002.

[27] Denotes target price.

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0014	Data (Exhibit C)	lot	$ 22,308	$ 24,581
0015	Maintenance repair parts (option exercised A007, 8, 13, 18)	lot	—	205,117[28]
0016	AN/SRN( ) Omega set	2	105,023	231,420
0018	Program controller	1	13,208	14,554
0020	AN/BRN-7 receiver set	53	48,100	2,809,106
0021	Interim repair parts	18 sets	19,877	258,401[29]
0022	Program Controller	53	13,208	771,362
0024	Establish repair and overhaul depot, and overhaul services	lot	447,085	447,085[30]
0034	BRN-7 for France[31]	1	48,100	53,002[31]
0035	Interim repair parts for item 0034[31]	lot	30,000	35,455[31]
0036	Maintenance repair parts[31]	lot	45,000	53,182[31]
0037	Program Controller[31]	1	13,208	14,554[31]
0038	Interim Repair parts for item 37[31]	lot	2,500	2,954[31]
0039	Maintenance repair parts Exhibit K[31]	lot	4,000	4,727[31]
0040	Technical Services foreign[31]	10 man-days	288	2,880[32/31]
0041	Support for item 40[31]	lot	Est.	620[32/31]
0042	Data[31]		Not Separately Price; included in item 37.	
0043	Interim repair parts Attachment D	lot	45,600	45,600[33]

[28] An additional $3,164,898 was obligated for spare parts ordered after the patent expired.

[29] Amount obligated as of July 22, 1975. Ceiling price is $301,750.

[30] Amount obligated as of July 22, 1975. Ceiling price is $510,000.

[31] Item purchased for Government of France.

[32] Denotes target price.

[33] *See* fn 30, *supra*.

Line Item	*Description*	*Qty.*	*Target Unit Price*	*Ceiling Price*
0044	AN/BRN-7 receiver sets	8	$ 48,100	$ 424,016
0045	Program Controller	8	13,200	116,360
0046	Interim repair kits	22 sets	21,300	468,600[34]
0047)				
0048)	Tape Cassettes	200 Sets	75	[35]
TOTAL				$12,353,957

120. The BRN-7 receivers do not include an antenna/coupler as one of the components. Rather each receiver, when installed, is connected to the standard submarine antenna and antenna coupler. These antennae and coupler units are capable of receiving a range of frequencies from VLF to HF and, therefore, are not limited to use with the Omega system, but must be employed when the Omega system is used.

121. The '816 patent claims a hyperbolic radio navigation system. (*Decca*, *supra*, finding 19). Such a system requires the use of a combination of receivers and transmitters. (*Decca*, *supra*, finding 4(a), at 23). The claims of the '816 patent do not define the structure of the respective components, *per se*. The claims merely require that the receivers and transmitters function in the manner set forth in the claims to provide the intended result. (*Decca*, *supra*, finding 19; see finding 26). As procured, the ARN-99 and BRN-7 receivers consist of components as set out in findings 114, 116, 118, and 120. These components were interconnected during first article and production-line testing, the ARN-99 and BRN-7 receivers being tested with Omega signal simulators rather than with transmissions from established Omega stations.

122. The following are components of an AN/ARN-99 receiver:

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[34] *See* fn. 31, *supra*.
[35] *See* fn. 32, *supra*.

(1) a receiver-computer group, OR-133(V)URN;
(2) a control indicator, ID-1776/ARN-99(V);
(3) an antenna-coupler, AS-2623/ARN-99(V); and
(4) a mounting base, MT-( )/ARN-99

The following are components of an AN/ARN-99(V)1 receiver:
(1) a receiver-converter, OR-90/ARN-99(V);
(2) an antenna-coupler, AS-2623/ARN-99(V); and
(3) a mounting base, MT-4534/ARN-99(V).

The post-installation differences between the two models is of no legal consequence.

123. Before an ARN-99 or BRN-7 receiver can utilize the frequencies transmitted as part of the Omega system in a navigation platform (which may be a submarine, ship, or an aircraft), a survey must be made of the platform. Racks to hold the receiver-computer and control-indicator must be fabricated and installed. The task of installing and interconnecting the receiver-computer, control-indicator, and interface group takes a total of 240 manhours for special Navy installation teams. The cost of installing a BRN-7 receiver in a submarine, for example, is approximately $7,000. Similarly, the cost of having a contractor assemble and install an ARN-99(V)4 receiver in an [EC-1300] EC-130Q aircraft is $15,895. This indicates an approximation of the amount of effort and cost required to install Omega receivers in submarines or aircraft.

124. The Government does not include certain components when ARN-99(V)1 and BRN-7 receivers are procured, since the antenna and antenna/coupler for the BRN-7 receivers are already aboard the submarines and the computers used with the ARN-99(V)1 receivers installed in aircraft are procured with the aircraft. In any event, the antenna and antennae/couplers are indispensable in use of the Omega system and the airborne computers enhance the value of the system in aerial navigation by providing a digital latitude/longitude readout. [There is no evidence of record to establish the number or cost of the computers which were procured by the Government during the term of the '816 patent, either separately or as components of procured aircraft.]

125. The '816 patented invention is "used" when a receiver receives and processes the Omega signals. (*Decca*, *supra*, at 19, 20). [Manufacture of the components of receivers capable of receiving and processing Omega signals by or for the Government constitutes contributory infringement of the '816 patent by the contractor. Transmission of the Omega format and contracting for the manufacture of receivers capable of using that format constitute active inducement by the Government of infringement, both by contractors and nongovernment users of the format and receivers.] The mere procurement of uninstalled and unconnected components of ARN-99 and BRN-7 receiver sets is not manufacture or use by or for the Government of the patented invention.

126. Of all ARN-99 and BRN-7 receivers procured by defendant, the following receivers were the only ones of which installation aboard their respective platforms was completed during the '816 term:

Type	*Qty.*	*Receiver Contract*	*Fiscal Year of Installation*	*Platform*
ARN-99(XN-1)	2	'0355	1969	P-3A, submarine
ARN-99(XN-2)	2	'0355	1971	P-3A/B
ARN-99(V)1	1	'0329	1973	P-3B
ARN-99(V)1	1	'0329	1974	P-3C

Type	*Qty.*	*Receiver Contract*	*Fiscal Year of Installation*	*Platform*
ARN-99(V)1	10	'0329	1975	P-3C
ARN-99(V)1	2	'0329	1974	CH-46E
ARN-99(V)4	2	'0372	1975	EC-130Q
BRN-7	18	'0209	1975	submarines

Generally, the above installation instances occurred in the latter half of the fiscal year. *Id.*

127. The patent in suit was first licensed by plaintiff through its wholly-owned subsidiary, Decca Navigator Company Limited [hereinafter DNCL] to the Bendix Corporation in November, 1961. Bendix was granted an exclusive license under the '816 patent, and 60 other listed patents, to [manufacture and sell] make, have made, sell and/or use transmitters and receivers for the Decca Navigator and DECTRA Systems. Also licensed was technical information, including data, drawings, and assistance,

as well as a right to use plaintiff's trademarks. In consideration of the license, Bendix was to pay a 7.5 percent royalty on the net selling price of receivers, transmitters, and parts thereof. Royalties were received by plaintiff from Bendix under this license. Bendix was also given the right to sublicense all rights it had received for which it would retain a 2.5 percent share (that is, a one-third portion) of the 7.5 percent royalty paid by the sublicensee. Thus, if the Government obtained a license from Decca or a sublicense from Bendix prior to litigation, the 7.5 percent royalty rate would have been an established reasonable royalty rate.

128. Prior to the 1961 license to Bendix, plaintiff licensed Bendix to use a pool of 51 patents, know-how, and trademarks for the Decca Navigator System. The license was exclusive except as to one licensee of Decca, and Decca itself, in the case of marine navigation systems. The patent in suit was not licensed and had not yet issued; however, the compensation for these licenses was a 7.5 percent royalty on the net selling price of licensed equipment. The license was dated October 27, 1954 and granted a "* * * license to make, have made, use, lease and/or sell, only for short and medium range navigational aid purposes * * * Decca Navigator System transmitters and receivers covered by and/or coming within the scope of any of the Licensed Patents." Payments were required "* * * on all sales or leases of Decca Navigator System transmitters, receivers and/or parts thereof * * *." *Id.* at 7.

Soon after Bendix entered into the 1954 license with plaintiff, it began to manufacture Mark V receivers useable with plaintiff's Mark V Decca Navigator System. Bendix re-received data packages from plaintiff under the 1954 license.

129. Prior to issuance of the '816 patent, the 1954 Bendix license was amended in September 1957 to include four additional patents with no changes in the royalty rate or base. Thus, in accordance with normal patent licensing practices, the royalty rate for the patents, plus a license for use of know-how and trademarks did not change in the subsequent 1961 Bendix license, even though the '816 patent was added.

130. Beginning with the 1961 Bendix license, plaintiff defined "transmitter" in several licenses which included the patent in suit as follows:

> 'Transmitter' shall mean all the technical equipment used in the production of satisfactory and reliable Decca or Dectra service from, but not including, the primary power supply to, and including, the dispatch of the service, but shall not include land, building, vehicles, diesels, real property improvements and the primary power supply.

Plaintiff's licenses to Applied Science Industries [ASI], Winder Aircraft [Winder], Laboratory for Electronics [LFE], as well as Bendix's sublicenses thereunder, to General Precision, Decca Systems, Inc., LFE and ASI, contained essentially the same provisions. In paraphrase, transmitter royalties were to be paid on everything from the power source to and including the transmission antenna.

131. The 1961 Bendix license also required Decca to pay Bendix a royalty of 2.5 percent of the net selling price of transmitters, receivers, and parts thereof sold by Decca or its subsidiaries in the United States. This provision was to compensate Bendix for its development expenses in connection with the equipment manufactured for use with the Decca Navigator System. This provision required Decca to use the limited definition of transmitter in the 1961 Bendix license in its computation of royalties due Bendix. In making such computations, Decca "broke out" from the applicable royalty base by excluding diesel generator sets and batteries, as well as land, building, real property improvements, and prime power supply.

The 1961 Bendix license states that the 7.5 percent royalty on transmitters, receivers and parts thereof is "in consideration of the technical assistance and information furnished and to be furnished," as well as the "licenses granted and to be granted." In 1964, Laboratory for Electronics (LFE), which was a sublicensee of Bendix pursuant to the 1961 Bendix license, notified Decca that a royalty payment on unpatented spare parts might be objec-

tionable to the United States Army, as the consideration for such payments on unpatented parts might be considered by the Army to be payments for know-how.

132. Decca received grant-back rights to improvements developed by licensees. The data flow from Decca to its licensees, however, exceeded the data flow from the licensees to Decca under the grant-back provisions of the license.

133. Decca included the following provision entitled "Exclusion for Research and Development" in several license agreements which licensed the patent in suit in connection with Decca Navigator and Dectra Systems:

> In the case of sales or rentals under contracts involving research and development effort the net selling price or rental shall be an equivalent fair market value of the apparatus actually delivered and shall exclude payment received for research and development effort not directly reflected in the fair market value of the apparatus.

This provision also appeared in sublicenses as from Bendix to General Precision Decca Systems, Inc., [hereinafter GPDSI], and a tripartite license of DNSI and DNCL to Astronics relating to Hi-Fix equipment. Thus, Decca did not charge a royalty on payments made under an R&D contract which were for R&D services, rather than for the apparatus actually delivered.

Decca also included in several licenses a term defining net rental to include "the rental element only and not any amount payable for repair and maintenance service to be furnished pursuant to a contract with the Lessee."

134. On March 31, 1969, Decca, through Decca Navigator Systems, Inc., entered into a license agreement with ITT Navigator Systems, Inc. [ITT/NSI] in an arm's-length, voluntary transaction. Decca received royalties under this license. This agreement licensed ITT/NSI to make, have made, use, sell, and/or lease transmitters and receivers. The '816 patent was listed in Schedule A and noted as applicable to Basic Mark 10, Omega and DELRAC. The Mark X Decca Navigator System, which includes transmitters and

receivers, comes within the scope of claims 1 and 11 of the '816 patent. The license to ITT/NSI was exclusive, subject to existing licenses, but there was an understanding that plaintiff would allow its existing licenses with others to expire in October 1970 so that the license to ITT/NSI would become exclusive thereafter. By their terms, the other licenses granted under the patents in suit expired by that time, and Decca gave notice of the terminations.

135. Of the 29 patents listed in Schedule A and licensed to ITT for particular fields of use, only seven had been licensed under the 1961 Bendix license, of which only six had been licensed under the 1954 patent license. The remaining patents issued after November 11, 1961, the date of the 1961 Bendix license. Thus, at the time of execution of the ITT license in March 1969, Decca's patent portfolio was decreasing and its early patents relating to the Decca Navigator System had expired or were expiring.

136. The license to ITT/NSI had a first compensation clause which applied only to Decca Navigator and DECTRA transmitters and receivers, while a second clause applied to all other Licensed Equipment. No royalties were paid under the latter clause with respect to Omega or DELRAC receivers, since those items were not developed or made by Decca. However, it was applicable to Omnitrac computers, LORAN-C equipment, Roller Maps, Data Links, and Automatic Pilots which were developed by Decca. Compensation was to be paid by applying a royalty rate to the net selling price, F.O.B. factory, and exclusive of packaging costs, of the relevant items.

137. The clause applicable to "all other Licensed Equipment" provided a 5 percent royalty on licensed equipment presently in existence. Omega/Delta equipment would have fallen within the second part of the clause, if they came into existence. The royalty of 5 percent was payable for 5 years from the date of first sale or lease. After that, the royalty would decrease to 2.5 percent except for items covered by one or more unexpired, licensed patents. For these items, the rate would remain at 5 percent. This rate was agreed to, however, 4 years after the Government adopted and proceeded with implementation of the Omega system.

138. While ITT/NSI never marketed any Omega or Delrac transmitters or three frequency receivers, the license indicates an agreed valuation of a license under Decca's patents, including the '816 patent as of March 1969.

139. No definition of transmitter appears in the ITT/NSI license.

140. As of March 31, 1969, when the ITT license became effective, the requirements for station electronics for permanent Omega stations had been determined. Although defendant had proceeded with implementation of the three-frequency Omega system as of April 1, 1969, defendant planned to use two-frequency BRN-4 receivers (manufactured by ITT) in submarines which would utilize the Omega system. As of this time, the ARN-99(XN-1) had not been completed and installed for testing. As of April 1, 1969, the license to ITT was sufficient to enable it to supply station electronics for defendant's permanent stations. This was theoretically possible, not only in light of ITT's license, but also its prior experience with the Omega system. However, as a practical matter, it was unlikely in view of defendant's decision to be its own "prime contractor" for establishment of all Omega stations and receivers.

141. The royalty terms in the ITT license were the result of arm's-length bargaining after defendant had made known its plans for establishment of the Omega system. At the time the license was granted, several of plaintiff's early patents had expired, but the unexpired '816 patent was expected to be the dominant patent in the licensed portfolio.

142. [ITT/NSI had a license not only to manufacture transmitters and receivers for the Omega and DELRAC systems, had such been developed, but it was also licensed to use them. Although ITT/NSI could have "used" the receivers and transmitters which it made, it was not licensed to build or operate a navigation system for which it made no components.] If and when Decca were to develop transmitters and receivers for the Omega system, ITT/NSI has a license not only to manufacture them, but it was also licensed to use them.

143. The royalty payable under an exclusive patent license, more often than not, is higher than that under a nonexclusive license. In this case, the "license" taken by defendant [was the

equivalent of] approximated an exclusive license under the '816 patent. [and all corresponding foreign patents owned by Decca, in view of defendant's preemption of Decca's worldwide exclusive rights].

144. In the electronics field, the Government normally seeks to [include] exclude spare parts, installation costs, transportation costs, packing costs, data costs, and engineering service from negotiated patent licenses. This practice has been followed by the Government in negotiated licenses on radar, radio telephone, and telegraph systems. The base upon which the royalty rate is computed in such negotiated licenses is normally the cost to the Government, as charged by the supplier.

145. Frequently, when the royalty rate is applied to a high royalty base, a lower rate is negotiated. Conversely, when a low royalty base is expected, a higher royalty rate is frequently negotiated. Decreasing, sliding-scale royalty rates are frequently used in negotiated patent licensing to allow for reduction in royalty payments as the volume of sales or production increases. Decca, in two negotiated patent and know-how licenses pertaining to LORAN-C, used a decreasing sliding-scale royalty rate. "Most favored" licensee provisions are not uncommon in negotiated patent licenses. Such a provision is contained in at least two of Decca's negotiated licenses.

146. Armed Services Procurement Regulations [ASPR] § 9-409.4(c) provide that indirect Government in-house costs, such as overhead and supervision, are not to be included in royalty bases in negotiated Government licenses. However, Government-furnished materials are normally included in the base, priced at the Government's cost.

147. Royalty rates for negotiated licenses under patents on electronics systems range from as little as 1.5 or 2 percent up to 10 percent, and sometimes even more.

148. A study of Government patent licenses in the electronics field prepared by the Government's expert indicates that the Government, in a negotiated settlement, obtained a license for PPI (plan position indicator) radar, bearing a royalty for future

procurement at a rate of one-fourth of 1 percent, with a ceiling of $2,900,000, or an effective overall royalty rate of .178 percent. This, however, is an abnormally low percentage rate as compared with percentage rates negotiated between willing licensors and willing licensees. It is not usual to set a ceiling on royalties, but ceilings may be placed on negotiated royalties where the ultimate base is unpredictable. The ceiling, however, usually reflects what the parties agree is adequate compensation for use of the invention.

149. There never has been an arm's-length commercial sale of an entire Omega system from which a fair market sale price can be determined [or upon which a royalty rate may be said to have been established]. The nearest system, by comparison, is Decca's MK X system. It is a Low Frequency (LF) system which has a short range and smaller equipment but, otherwise, it is the same in principle as Omega, and is generically covered by the patent in suit. The technical problems of erection are substantially the same. Decca sold such systems as "turn key" jobs. [Thus, the sale pricing methods used by Decca in the sale of its MK X systems are relevant. However, they are not totally comparable because the profit margin enjoyed by Decca in such sales was influenced by the fact that] Decca's MK X system was in direct competition with the LORAN-C system for short-range usage. [Also, Decca's MK X system did not offer an advantage of cost saving in the short range context anywhere near comparable to the $640 million more which LORAN-C would have cost over the Omega system, for worldwide coverage, or the capability of use by submerged submarines which the infringing Omega system provides. Accordingly, the profit mark-up for the sale of an entire Omega system should be at least equal to Decca's profit mark-up derived from its MK X system sales.]

[150. The fair market value of the tangible elements of the infringing Omega system to be included in the accounting also includes the fair market value of the receivers procured by the defendant. All procurements of the three-frequency receivers designated AN/ARN-99 and AN/BRN-7 up to July 22, 1975 are,]

[therefore, includable, plus 60 single frequency receivers. The 60 single-frequency receivers are includable on the ground that they were required for system calibration and monitoring. A receiver which indicated the position fix in terms of latitutde/longitude is also an element of the infringing system. Omega receivers, even those receivers which are implemented for rho-rho, employ the hyperbolic mode virtually all of the time. Thus, there is no substantial difference between the rho-rho and hyperbolic modes. Since all of defendant's activity in the procurement of equipment for transmitting stations and three-frequency receivers up to July 22, 1975 was intended for use in the infringing Omega system, such procurement was contributory to, or actively induced the infringement; hence, such procurement is includable in the compensation.]

[151. The infringing Omega system is unique. No other system has been shown to provide continuous, worldwide medium accuracy radio navigation, with ambiguity resolution comparable to that of the Omega system, or with accuracy for relative navigation as high as that provided by the infringing system. No other radio navigation system has been shown to be capable of being used effectively for submerged submarines. LORAN-C signals (the next-best alternative) penetrate only a few feet into sea water. Compared to the LORAN-C system, Omega was expected to afford a cost saving to defendant of over $640 million over a 10-year period. The operational cost saving on a single trans-Pacific voyage of a commercial surface vessel, by using the Omega system as compared with using any other available system, is as much as $5,000.]

[152. When defendant first made the Omega system operational on October 24, 1967, Decca lost its potential market for sale or licensing of a Delrac/Omega-type of system to defendant and all others. Based on Decca's computations, the total price of such a system as it existed on June 30, 1975 would have been $129,709,000. Decca estimates its profit on such a system would have been at least $22,167,000. If weight is given to the urgent military and non-military requirement for the Omega system and]

[the substantial saving to the Government by using the Omega system as compared with LORAN-A or LORAN-C, Decca would have been entitled to a profit mark-up higher than that used in its commercial sales of the MK X system, namely 30 percent. Based on such calculations, Decca estimates the cost of the system would be $139,805,000, which would include a profit of $32,263,000.]

153. Plaintiff recognized in the definition of "transmitter" which appears in the 1961 Bendix license, that land, buildings, real estate improvements, vehicles, diesels, and prime power were not to be included as part of the royalty base upon which the licensees were to pay royalties.

154. There were no acts of infringment for which defendant is held liable after July 22, 1975, the expiration date of the '816 patent. Although the stations at LaReunion, Liberia, and Argentina, as well as the planned station in Australia, were not operational prior to July 22, 1975, defendant had contracted for all equipment associated with them prior to that date. [The contract price of all ARN-99 and BRN-7 receivers for which contracts were executed prior to July 22, 1975, should be included in the compensation base, if procurement figures are to be used in arriving at the base, since defendant actively induced the contractor(s) to contribute to the defendant's ultimate infringement in the "manufacture[d] or use[d] by or for the government" of the Omega system.]

155. If compensation is to be based on cost of establishing the system, the "entire market value" rule as delimited by the definition of "transmitter" in the Bendix license, is applicable for purposes of determining the quantum of liability. Even though widely separated physically, each transmitter and receiver contributes to the system as a whole, and each performs a necessary function. For example, at each station the tower or valley span will not stand up without the entire system of guys, anchors, and foundations. The antenna will not radiate effectively without the insulators or the conductive ground system. The helix and transmitters, in order to assure continuous operation, must be housed in specially designed buildings. Redundancy of certain parts and spares is necessary due to the need for continuous "on air" capability. Everything within

the walls of the transmitting and monitoring stations is at least "reasonably" necessary. [Virtually the entire procurement relating to Omega was financially tied to the market created by the patented system.]

156. The 10.2 kHz frequency transmitted as one frequency of the Omega system is capable of noninfringing use. The Omega system, however, is utilized in initializing such single-frequency receivers. [and the '816 patent is infringed whenever such a receiver utilizes the three transmitted Omega frequencies from at least two stations. The number and cost of receivers under procurement or installed as of July 22, 1975, thus may be taken into account in determining the compensation base].

[157. The compensation base, even if computed on the basis of the lower ITT license and limited to the procurement costs of only the station electronics and receivers used in combination during the term of the '816 patent would be as follows:

Receiver Type	*Qty.*	*Unit Cost*	*Total Cost*
ARN-99(XN-1)	2	$192,480	$ 384,960
ARN-99(XN-2)	2	112,036	224,072
ARN-99(V)1	1	22,445	22,445
ARN-99(V)4	2	60,399	120,798
BRN-7	18	53,002	954,036
			$1,706,311

	Installed Cost	*Less Installation Cost*[38]	*Total Cost*
Station Interim:			
Hawaii	$562,301	$15,400	$ 546,901
Norway	569,940	17,800	552,140
Forrestport	620,151	16,200	603,951
Trinidad	658,565	21,750	639,906
			$2,339,898

[38] The installation costs can be identified by summing the costs for "installation" and "Travel & Per Diem" set out in DRF 78, pp. 42-43.]

[*Permanent:*	*Cost*	
North Dakota	$1,061,435	
Norway	1,061,435	
Hawaii	1,061,435	
Japan	1,061,435	
	$4,245,740	
Receivers		$1,706,311
Interim station Electronics		2,339,898
Permanent Station Electronics		4,245,740
		$8,291,949]

[158. Defendant's actions were more than a mere taking of a nonexclusive license since the effect of those actions was to preempt the world market for plaintiff's goods, services, and patent rights. Moreover, defendant's actions left Decca completely at defendant's mercy as to Decca's future manufacture, licensing, or sale or the nature and scope of receivers, since defendant would have control of the transmission segment of the system. Accordingly, when defendant, for reasons of its own, ordered a cut-back in funds for completion of the Omega system in 1972, the procurement of receivers was affected. Decca, however, was not in a position to go out and make up for the reduced market, since it nor anyone else would be likely to build additional transmitters. The availability of such an option had been permanently preempted by defendant's overt implementation of the Omega system. Accordingly, the extent of defendant's actual use of the rights it took under the eminent domain license is not a complete measure of the value *to Decca* of the rights which were taken by defendant.]

159. Plaintiff's license to ITT/NSI provided a royalty rate of 5 percent for an exclusive license in its patents, including the '816 patent in suit. The United States, having [taken a nonexclusive license in the '816 patent by eminent domain prior to the granting of the ITT/NSI license,] announced and having proceeded to implement its intention to establish Omega, caused plaintiff to accept a reduction in the royalty rate from ITT/NSI as compared

with that provided under the Bendix license. [Since plaintiff was not given an opportunity to bid on the establishment of the Omega system for defendant, plaintiff lost its opportunity to make and sell Omega transmitters and to control use of the Omega system.] The 5 percent royalty rate, therefore, should not be considered a reasonable rate, but a forced minimum.

160. Since the royalty rate for an exclusive license may be 50-100 percent higher than that for a nonexclusive license, a reasonable royalty under the ITT/NSI license, if truly exclusive, would have been at least 7.5 percent. [The Government's contribution in developing the sophisticated Omega station electronics and receivers which it used was insignificant in comparison with the total cost of establishing the worldwide Omega system.] No decrease in the royalty rate is warranted on account of defendant's in-house development, since the value of such contribution[, if any,] was taken into account in the prices paid for the components procured from defendant's suppliers. [Taking into account all of the evidence in this case, Decca would not have granted defendant a license to establish the worldwide Omega system for a royalty of less than 10 percent of the cost of establishing the system if constructed on a competitive bid basis.]

[161. It is a sometimes practice in the patent licensing field to use a step or decreasing sliding-scale royalty to provide for decrease of royalty rates to the patentee as the base increases or, conversely, for the increase of royalty rates as the base decreases. In some cases decided by this court a 3 percent royalty has been applied to the first $5 million of the base, and a 2 percent royalty on all amounts over $5 million. A sliding-scale royalty is inappropriate in the present case since the single infringement (establishment of the worldwide Omega system) saturated not only the domestic (United States), but also the foreign (worldwide) market for the system, the components of the transmitting stations and licenses under plaintiff's domestic and foreign patents. Where the royalty is based on savings to the licensee, it is proper to prorate the estimated savings over the life of the patent, starting from the date of first exercise of the licensee's right under the patent.]

[162. Defendant's declaration of "Operational" Status for the Omega system on October 24, 1967 was the first infringment in terms of use of plaintiff's rights, at least in the sense of inducement, and the use of the interim system with a bank of three single frequency receivers (each tuned to a separate one of the Omega frequencies) was a complete, direct infringement by defendant. Therefore, delay damages should start as of October 24, 1967, and be computed at the rates set forth in *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106, 192 USPQ 612 (1976), *cert. denied*, 434 U.S. 1051 (1978). To account for the continuing nature of defendant's infringements, the basic award of $24.8 million is prorated from this date to the date of expiration of the patent (July 22, 1975). The award is not prorated uniformly over this entire time period, however, because it is clear that the Government did not immediately realize the full economic benefit of the Omega system during the early stages of its infringement. Accordingly, the award is prorated based on the empirical projection that the Government did not realize the full economic benefit of the Omega system until 1971, and that it realized only half of the system's economic benefit during the infringement period prior to 1969.]

[163. Rates of delay compensation to be applied to the compensation base (basic compensation) are as follows:

10/24/67-12/31/70	6.5 percent
1/1/71-12/31/75	7.5 percent
1/1/76 to payment	8.0 percent]

[164. Delay compensation is measured by simple interest running from the first day on which the royalty became payable. In this case, royalties first became payable on October 24, 1967 when the Omega system was first declared operational by defendant, and the operation thereof was guaranteed by defendant for at least one full year. Royalties for subsequent years became due at the end of each calendar year.]

[165. Based on the delay compensation rates specified in finding 163, the yearly delay compensation owed by defendant on the basic $24.8 million award, prorated in accordance with finding 162, is as follows:

Year	*Prorated Base (Annual Increment in Millions*	*Delay Compensation Rate*	*Delay Compensation*
10/24/67-12/31/67	1.0	6.5	$ 12,109
1/1/68-12/31/68	1.5	6.5	162,500
1/1/69-12/31/69	3.0	6.5	357,500
1/1/70-12/31/70	3.0	6.5	552,500
1/1/71-12/31/71	3.5	7.5	900,000
1/1/72-12/31/72	3.5	7.5	1,162,500
1/1/73-12/31/73	3.5	7.5	1,425,000
1/1/74-12/31/74	3.5	7.5	1,687,500
1/1/75-7/22/75	2.3	7.5	1,034,465
7/23/75-12/31/75	24.8	7.5	820,436
1/1/76-3/31/79	24.8	8.0	6,441,205
		Total Delay Compensation (Up to and including March 31, 1979)	$14,555,715
		Total Basic Compensation	$24,800,000
		Total (Reasonable and Entire) Compensation (Up to and including March 31, 1979)	$39,355,715
		Further Delay Compensation (April 1, 1979 to date of payment of judgment)	$5,436/per day]

162-165. Delay compensation is measured by simple interest running from the first day on which a royalty became payable. Delay damages should be computed at the rates set forth in *Pitcairn* v. *United States*, 212 Ct. Cl. 168, 547 F.2d 1106 (1976), *cert. denied*, 434 U.S. 1051 (1978). In light of the affirmative showing on the part of plaintiff of a higher delay compensation rate for years after 1975 than that stated for the quinquennium of 1971 to 1975 in *Pitcairn*, a rate of 8 percent will be applied for years after 1975, up to and including the date of payment of the judgment.

[166. Defendants calculations of basic compensation and delay compensation thereon, which are rejected, are as follows:

Fiscal Year	*Item*	*As Installed Procurement Cost*	*Apportionment Factor*	*Apportioned Cost for Base*	*Royalty Rate*	*Royalty*	*Cumulative Rate*	*Delay Compensation 12/31/77*
1969	*Basic 10.2 Electronics*							
	Hawaii - Interim	$ 488,901	0.047	$ 22,978				
	Forrestport - Interim	456,751	0.047	25,697				
	Norway - Interim	496,540	0.047	23,337				
	Trinidad	585,256	0.047	27,507				
	11⅓ and 13.6 Add-On							
	Hawaii - Interim	73,400	0.658	48,297				
	Forrestport - Interim	73,400	0.658	48,297				
	Norway - Interim	73,400	0.658	48,297				
	Trinidad	73,400	0.658	48,297				
	Station							
	Forrestport - Interim	30,000	0.047	1,410				
	Norway - Interim	1,119,783	0.047	52,630				
	Trinidad	839,701	0.047	39,466				
	Two ARN-99(XN-1)	416,750	1.0	416,750				
	Fiscal Year Total	$4,817,282		$802,963	1.8%	$14,453	62.25%	$8,997]

[

Fiscal Year	Item	As Installed Procurement Cost	Apportionment Factor	Apportioned Cost for Base	Royalty Rate	Royalty	Cumulative Rate	Delay Compensation to 12/31/77
1971	Two ARN-99(XN-2)	$ 255,862	1.0	$255,862				
	Fiscal Year Total	$ 255,862		$255,862	1.8%	$ 4,606	48.75%	$ 2,245
1973	*North Dakota*							
	Basic 10.2 Electronics—11⅓	852,593	0.047	40,072				
	and 13.6 Add-On Station	127,849	0.658	84,125				
	One AN/ARN-99(V)1 in P-3B	3,275,607	0.047	153,954				
	Fiscal Year Total	38,340	1.0	38,340				
		$4,294,389		$316,491	1.8%	$ 5,697	33.75%	$ 1,923
1974	*Norway*							
	Basic 10.2 Electronics—11⅓	743,887	0.047	34,963				
	and 13⅓ Add-On Station	122,241	0.658	80,435				
	Fiscal Year Total	2,145,985	0.047	100,861				
		$3,012,113		$216,259	1.8%	$ 3,893	26.25%	$ 1.022
1975	*Hawaii*							
	Basic 10.2 Electronics—11⅓	962,209	0.047	45,224				
	and 13⅓ Add-On Station	126,070	0.658	83,954				
		3,595,756	0.047	169,001				

(Continued on next page)]

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Fiscal Year	Item	As Installed Procurement Cost	Apportionment Factor	Apportioned Cost for Base	Royalty Rate	Royalty	Cumulative Rate	Delay Compensation to 12/31/77
1975	*Japan*[37]							
	Basic 10.2 Electronics—11⅓	$ 852,593	0.047	$ 40,072				
	and 13.6 Add-On Station	127,849	0.658	84,125				
	Two[38] ARN-99(V)4	3,275,607	0.047	153,954				
	Eighteen[38] BRN-7	152,588	1.0	152,588				
	Fiscal Year Total	1,080,036	1.0	1,080,036				
		$10,172,708		$1,807,954	1.8% on 1st $408,425 (so that cumulative base equals $2,000,000) and 1.5% on balance of $1,399,529	$ 7,352	18.75%	$ 1,378
						$20,993	18.75%	3,936
TOTAL		$22,552,354		$3,399,529[39]		$56,994[40]		$19,501

[37] The procurement cost figures used for Japan are those for North Dakota, since Japan designed and constructed its own station using U.S. furnished station electronics, bushing, and some services. From DRF 72, the actual cost to the United States was: $629,211 for "Basic 10.2 Electronics," $109,719 for "11⅓ and 13.6 Add-on" and $86,541 for "Station." The use of the higher North Dakota figures, rather than the actual costs borne by the United States results in increases in the total royalty and delay compensation.

[38] One ARN-99(V)4 and four BRN-7 receivers were actually installed in July 1975. To simplify calculation, include in FY 1975.

[39] Difference between total of $3,399,529 and $3,399,528 in DRF 139(d), p. 96, *supra*, is attributable to rounding off to nearest whole dollar.

[40] Difference between total of $56,994 and $56,993 in DRF 144, p. 102, *supra*, is attributable to rounding off to nearest whole dollar.]

[CONCLUSION OF LAW

Upon the findings and foregoing opinion, which are adopted by the court, the court concludes as a matter of law that plaintiff is entitled to recover the sum of twenty-four million, eight hundred thousand dollars ($24,800,000.00) as basic compensation, and the sum of fourteen million five hundred fifty-five thousand seven hundred fifteen dollars ($14,555,715.00) as delay compensation through March 31, 1979, plus further delay compensation at the rate of five thousand four hundred thirty-six dollars ($5,436.00) per day from April 1, 1979 to the date of payment of the judgment.]

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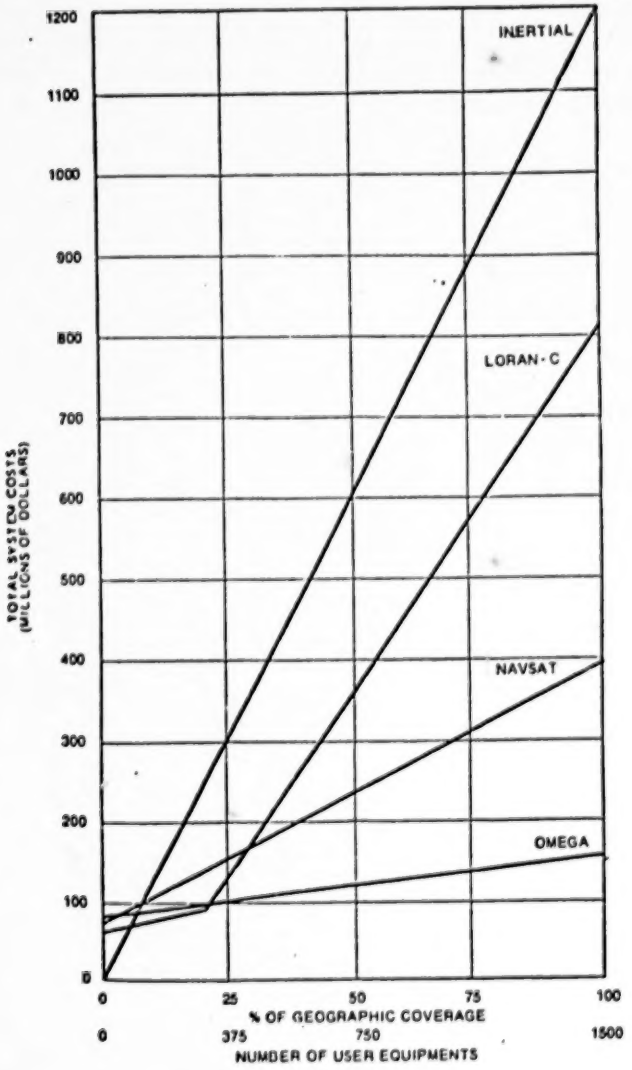


Figure 5-4. Total System Costs vs. Percent Geographic Coverage for Candidate Navigation Systems